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# NEW DESTINIES



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# **NEW DESTINY**

Fall Edition 1987

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**NEW DESTINIES, Fall 1987**

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## **Introduction to RUNNING OUT**

*Though we usually limit ourselves to one fiction and one fact piece per author, we begin this issue with three pieces by noted space scientist and science fiction author, Charles Sheffield. Our reason for this deviation? Simple: to avert a lynching.*

*After reading the piece which follows this one, remember that the same author wrote "RUNNING OUT," and that it may therefore be assumed that "DO YOU REALLY WANT A BIGGER SPACE PROGRAM" was offered in a spirit of devil's advocacy. It is, in other words, a think piece. Really it is. . . .*

# RUNNING OUT

*Charles Sheffield*

1. *Introduction.* Four hundred years ago, the intelligentsia of Europe were worried. A major crisis was on the horizon, and it was expected to arrive in, at most, a couple of generations.

The problem was energy shortage—fuel wood was being used up faster than it could be replenished. The forests of Europe were shrinking, and it was only a matter of time before they would all be gone. When that happened, what would civilized nations do for energy?

As Marie Antoinette might have said, let them heat coke. That's what they did. Coal and coke replaced wood and charcoal as the primary sources of energy, the crisis went away, and Europe could breathe easy for another few hundred years and get on with the serious business of war.

Now we are again facing shortages, but they are worldwide and there are more of them. We can see on the horizon shortages of fuel, forests, food, water, and a dozen other resources. In fact, the pessimists among us insist that we are running out of *everything*, and time is running out, too. The real pessimists go further: time has already run out. Nothing *can* be done; we are already too late.



The optimists are rather harder to take. They deny that there is any problem at all, and they come in several varieties. Some, like former Interior Secretary James Watt, argue that we do not need to worry about conservation or the environment, since the Second Coming is just around the corner and Earth will pass away (just the sort of man you need to look after the National Parks). Others, like Lyndon LaRouche, insist that the problems are part of a strange plot involving, among others, the Soviet Union, the Queen of England, the International Monetary Fund, and Henry Kissinger (I'm not making this up, you know) and that if we only had more people in the world, the resource problems would all magically be cured.

I'm rather less sanguine. I think we do have resource shortages, and tough problems. But unlike the pessimists, I think they can be solved. The first thing we have to do with the problem is understand its nature, size, and timing. We will start with the most famous shortage, though not in my opinion the most serious one.

**2. Energy.** The most publicized shortage in the United States, and the one that was brought to everyone's personal attention during the 1973 Arab oil embargo, is energy.

That may, however, be the wrong place to set our focus. Laying publicity and a possible dislike for OPEC aside, what is the world's most *important* energy source?

This sounds like a fair question, but it doesn't have a unique answer. One answer—a very reasonable one—would be the sun. We depend on the sun for everything—for warmth, for growing plants, and originally, for all fossil fuels. However, most people mean *generated* energy when they speak of energy shortages. Sunshine is not enough to make them happy.

Another reasonable answer would be fossil fuels—specifically, oil, coal, and natural gas. Today, oil provides more (37.2 percent) of the world's generated energy than any other source. (Generated energy includes ev-

everything except natural sunlight). Coal accounts for another 28.6 percent, and natural gas for 18.5 percent. Nuclear and hydroelectric power, together, provide another 10.1 percent, while everything else—winds, tides, wood, and geothermal—totals only 6 percent or less of world energy consumption.

The uncertainty in that final 6 percent figure is considerable. Statistics on the use of non-fossil fuels around the world are hard to come by, because those fuels are less used commercially and their transactions are poorly recorded. Table 1 shows the best estimates I can make on the percentages of energy derived from different sources. It is based on commercial energy use as given in the *British Petroleum Statistical Review of World Energy*, 1985, modified by the fuel wood use estimates of the Food and Agriculture Organization of the United Nations, as given in the *Yearbook of Forest Products*. I had to juggle the numbers for myself, and would not trust any of them past the first significant figure (and maybe not even that far).

TABLE 1: Energy Supply.

Source	Amount (millions of tons of oil equivalent)	Percentage of Total
Oil	2,840	37.2
Coal	2,180	28.6
Natural gas	1,410	18.5
Hydroelectric	490	6.4
Wood	430	5.6
Nuclear	280	3.7

A third answer to the question of the most important energy source is appropriate if by "most important" we mean "vital to the largest number of people." Wood is still the major fuel for an estimated 2.5 billion people—more than half the world's population. In the poorest countries, wood, crop residues, and dried animal dung provide more than 90 percent of household energy. In most of these countries, wood is being used up faster

than it is being grown, and dung that should be used as fertilizer goes up in smoke.

Burning wood and dried dung for fuel will come back to haunt us (see Section 6). Organic matter is needed to bind topsoil, and prevent its erosion. For the moment, however, let us stay with commercial energy generation, and the potential shortages in that area. We will begin with good old OPEC.

*Oil.* Global oil consumption has been almost constant for the past 14 years, since the trauma of the 1973-74 oil price increases. Its use will continue to fluctuate with the rise and fall of oil prices relative to other fuels, but for the purposes of projection, we need to make some assumptions about both its rate of use and rate of new field discovery. We will assume that production and consumption continue at about their present levels, and that global oil reserves (known and unknown) are somewhere between 1.6 and 2.4 trillion barrels (this is M. King Hubbert's estimate; he is the man who in the 1950s practically started the whole business of detailed oil reserve estimates, and he has consistently been more accurate than almost everyone else on discovery rates). Those two assumptions tell us that the reserves will carry us into the second quarter of the next century. Improved use of oil tar sands and oil shales may extend that deadline. To have something specific to work with, though, let's stay with our original assumptions, which tell us that oil use must fall off drastically at about 2,040.

*Coal.* The prospects for coal are somewhat better. Coal is a variable fuel, ranging from clean-burning, low-ash anthracites to dirty and sulfurous lignites. If we can clean coal up enough to burn it without poisoning ourselves, there are at least 500 billion tons of coal that can be readily mined. That is a World Energy Conference *Survey of Energy Resources* 1983 figure, and it is more than a hundred years' supply at present use rates.

The estimate of *total* coal reserves, as opposed to seams that can easily be mined, is 10 trillion tons (Reference: *Environmental Implications of Expanded Coal*

*Utilization*, by M. Chadwick and N. Lindman, Pergamon Press, 1982). That amount would be several thousand years of supply at current use rates. However, coal is not a clean fuel, either to mine or burn. Difficulties with Federal mine safety regulations on the one hand, and Environmental Protection Agency restrictions on coal use on the other, have led baffled energy analysts to say, "Coal would be a great fuel, if only we were allowed to mine it and burn it."

Let us be conservative. If we assume that we can find a way to burn coal cleanly, we have comfortably enough coal to last us through the year 2,090.

*Natural gas.* The reserves of gas are less well-documented than oil reserves. The best numbers I can find are those in two documents: the Gas Energy Review figures from *World Gas Supply and Demand, 1983-2000*, published in 1985; and the Office of Technology Assessment's report: *U.S. National Gas Availability: Gas Supply Through the Year 2,000*, also published in 1985. These references suggest that we have 60 years of supply at present use levels. This could change a lot on the supply side if systematic prospecting turns up the large new gas fields that many geologists believe are there, or if "unconventional" gas resources, such as tight gas and coal seam methane, provide significant production. But even without these, it seems unlikely that we will run out of natural gas much before the year 2,050.

*Nuclear energy.* Ah, here's a tangled web, and one that we will be able to neither unravel nor escape from. Even before Chernobyl, the nuclear program in this country was in a shambles. America produces more nuclear energy than any other country (see Table 2), by a factor of two. But no orders for new nuclear reactors have been placed in the U.S. since 1978, and all 13 orders placed between 1975 and 1978 have been either cancelled or deferred indefinitely. Meanwhile, construction costs have doubled, and cost per kilowatt of electricity has quadrupled. As the Office of Technology Assessment's 1984 report, *Nuclear Power in an Age of*

*Uncertainty*, rightly concludes, nuclear power in the United States has a very unpromising future.

TABLE 2: Nuclear Power Production (in 1984).

Country	Power (in gigawatts)
United States	71.2
France	33.3
USSR	24.1
Japan	21.8
Germany	16.1
United Kingdom	10.7
Canada	10.0
Sweden	8.4
All others	31.0

How should we make our projections? My belief is that other nations will continue to invest in and to commission nuclear power stations. France and Japan in particular have made national commitments to nuclear energy programs. As the years roll by, and more operating experience is gained, I hope that the United States will shed some of its present hysteria, and move again to nuclear power.

As you can see, Chernobyl notwithstanding, I approve of nuclear energy. And yes, I would be quite willing to live close to a nuclear station. Before I came to the United States, I worked in reactor design. Nothing I saw then, or have seen since, has made me feel that the aggregated dangers of nuclear power stations are as bad as those of coal-powered stations—though we have admittedly managed to load nearly all the risks of the latter onto the coal miners.

3. *Food*. I was tempted to begin with this one. We can live without the use of fossil fuels and industrial minerals for a long time, and our ancestors did so for millions of years—albeit with living conditions we might not find pleasant. But without food, we would all be dead in a couple of months.

Then I looked a little further into supply and de-

mand, and changed my mind. I almost wanted to leave food out completely. The situation is such a perplexing mess.

*Paradox One:* In a world population of close to five billion people, half a billion—10 percent—live in a state of severe malnutrition. At the same time, the world is amassing mountains of food, underground caverns are filled with millions of tons of grains and dairy products, and American farmers are being paid large amounts of money *not* to grow food.

*Paradox Two:* Thirty years ago, everyone was predicting starvation in India and China by 1985. In 1985, India and China were self-sufficient in food production. Saudi Arabia, most people's last choice for food exporter, grew more food than it could use in 1986.

How, given this degree of confusion, can anyone make rational projections for a generation or two into the future? All we can do is examine the reasons for today's paradoxes, and see what that teaches us.

"Real food demand" and "effective food demand" sound as though they ought to mean the same thing. They do not. *Real* food demand is the need for food. *Effective* food demand is the commercial market for food. People who are both very hungry and very poor certainly have a real demand for food, but since they have no money, they cannot buy it. And because they cannot buy it, and farmers cannot afford to give it away, national governments are obliged on the one hand (like the U.S. Government) to buy excess crops from their farmers and stockpile them, and on the other hand (like the governments of many African countries) to seek free food for their people in the form of international aid—which will, in turn, tend to dishearten and destroy the country's own farm economy, which cannot compete with free imports.

What is the solution? I can see only one: the agricultural economies of the poorer countries (today, most of them are in Africa) must be boosted to the point where they can feed the populace.

If that sounds hopeless, we can look to our second

paradox to give us comfort. The 1950s projections of the Chinese and Indian situations were hopelessly wrong because no one anticipated the spectacular crop increases produced by the "green revolution" that began in the 1960s. New varieties of dwarf rice, semi-dwarf wheat, and maize increased cereal yields enormously, and boosted crop production ahead of population growth. These high-yielding plant varieties had specialized growth needs, including fertilizer, pesticides, and lots of water. China and India could provide these, particularly through irrigation. Africa, much of it drought-stricken, could not.

What are the chances that new variety development will do for Africa in the next twenty years what the green revolution did for South and East Asia in the last twenty? The chances are surprisingly good. Recombinant DNA techniques applied to food crops should yield high-producing, drought-resistant and insect-resistant strains. Hybrids that incorporate the nitrogen-fixing root systems of legumes into other food crops will decrease or even eliminate the need for fertilizers. Within a decade, we are likely to see a new green revolution. This one will help Africa, which today suffers the worst agricultural problems on Earth.

4. *Water*. If food is essential to life, water is more so. Without food, we may live on our fat for two months. Without water, we would all be gone in a couple of weeks. We call our planet "Earth," but a better name might well be "Water." The whole globe is 70 percent covered with oceans, and one might think that the last area where we will have shortage problems is in water supply.

Simple arithmetic seems to support that idea. Of the roughly 1.4 billion cubic kilometers of water in earth's outer layers, 97 percent is the salty brine of the oceans. That leaves 42 million cubic kilometers of fresh water; but more than three quarters of that (77 percent) is locked up in the "cold storage" of glaciers and ice caps. We are now down to 10 million cubic kilometers. Of

those 10 million, 9.8 million are held in underground aquifers, or as soil moisture, or as atmospheric water vapor. The readily available supply of fresh water has thus been whittled down from the original 1.4 billion cubic kilometers to about 200,000, held as river and lake water, swamps, or water used by plants. The total water budget is shown in Table 3.

TABLE 3: The World's Water Budget.

Storage Medium	Volume (1000's cu.kms.)	Cycle Time
Atmosphere	113	1 week
Oceans	1,370,000	5,000 years
Freshwater lakes and reservoirs	125	Days to years
Saline lakes	100	?
Rivers	1.7	2 weeks
Swamps	3.6	Years
Plants	65	1 week
Soil moisture	65	2 weeks to 1 year
Aquifers	4,000 to 60,000	Days to thousands of years
Glaciers and ice caps	30,000	Tens to thousands of years

(Reference: R.L. Nace, *Water of the World*, U.S. GPO, 1980)

How much is 200,000 cubic kilometers? The cubic kilometer is not a unit we usually associate with water. We are more familiar with gallons, or barrels, or bathtubs.

The conversion is easily done. One cubic kilometer is a billion cubic meters, and one cubic meter of water conveniently weighs about one ton. Since a gallon of water (American gallon, that is; the Imperial gallon, if you happen to be reading this in England, is 20 percent larger) weighs eight pounds, one cubic meter contains 250 gallons. Therefore, Earth's 200,000 cubic kilometers of fresh water is equal to 50,000 trillion gallons, or ten million gallons for every man, woman, and child living. If we all lived to be a hundred, that would



provide us with 275 gallons of fresh water a day; enough, one might think, for even the most frequent bather.

And this ignores the fact that the sun's heat is continuously evaporating new fresh water from the surface of the oceans, leaving a slightly saltier ocean behind. Every day about 1,250 cubic kilometers of water are raised into the atmosphere in this way. Ninety percent of it falls back into the oceans as rain or snow. The rest, falling onto the land, provides about 600 gallons a day, every day, for every person on earth.

And yet the world is running short of fresh water. Part of the reason is that our personal consumption is more than we see running out of the faucets in our house. It must include all the gallons of water used in the industries that produce our food, light our homes, and clothe our bodies. In the United States, only one-tenth of the fresh water used goes to home supply and sewage systems. Two-fifths goes to agriculture, and the other half to cooling electricity generating plants and other industrial use. Worldwide uses vary greatly. Egypt and Oman use 98 percent of their water on irrigation, and a negligible amount on industry, whereas Finland uses 85 percent of its water on industry, with only 7 percent for private use and 8 percent for agricultural irrigation.

A more important reason for the increasing fresh water shortage derives from the fundamental nature of water itself. It is one of the best solvents we know. As a result, it is terribly easy to pollute. A little carelessness, and the output from a power plant or a city's sewage system will spread through and pollute many billions of gallons of the water supply. (And the pollution can persist for a long time; the kepone deposited into Virginia's James River will poison that estuary for many years to come.)

One proposed "long-term" solution to water pollution is desalinization. It is easy enough to evaporate sea water, or run it through a reverse osmosis process, and make fresh water. But that takes energy. It is better, I feel, to clear up the problem at the source. Factories

and cities should not be allowed to pollute the rivers and lakes that receive their effluents. The easiest way I know of to stop them (and one which this country, for some reason, has largely failed to accept), is ludicrously simple: a city or factory should draw its water intake downstream of its output.

Finally, and most familiar, there is a problem of distribution. Seattle has a lot more rainfall than Death Valley. The distribution of fresh water, like the distribution of food, is uneven around the world. A Canadian has available twenty million gallons of fresh water a day; a Libyan has less than 140 gallons. On a continental scale, Africa has only one-fifth as much fresh water runoff to the oceans per unit land area as South America.

We are not "running out" of water, and thanks to the beneficence of the sun, we will never run out completely. There will always be renewal from ocean evaporation. However, total water use quadrupled between 1940 and 1980, moving up to nearly 4,000 cubic kilometers a year. If that growth rate continues, global fresh water needs will match total fresh water production by the year 2,050. Long before that, we could pollute and poison our supply to the point where it is useless. In practice, we will be forced to change our ways.

5. *Forests.* Until five hundred years ago, the idea of preserving forests was an eccentricity. When Artaxerxes, in 350 B.C., tried to prevent the cutting of cedar trees in Lebanon, he was considered a little strange. And rightly so. At a time when forests represented dark, dangerous places, perhaps populated by wild men and spirits, the less you had of them, the better. Cutting down forests could not be a bad thing, since the forests were presumed inexhaustible. And they were close to it. As recently as fifty years ago, 70 percent of the planet's forests had never been touched.

Forests still cover over one-third of the land areas, but today the woods of the world are being assaulted from two different directions. The tropical rain forests are being cut down, for fuel and for new crop-planting

area, at a rate of 32,000 square miles a year. That's like losing Maine this year, South Carolina next year, then Indiana, and so on, indefinitely—or until we run out of forest area. Fortunately, we have rather a lot of tropical forest—about 10 million square miles of them. At today's rate of deforestation, it will be another two or three hundred years before everything is gone. However, long before that, there will be other dire effects on the environment. See Sections 6 and 7.

Unfortunately, the loss of tropical forest area does not mean we gain valuable croplands. The soils covered by these woodlands are infertile, easily leached of nutrients, and very subject to erosion. A few years after the trees are removed, the topsoil disappears. Instead of farmlands, we have barren regions that grow nothing better than tough grasses, useless for food, fuel, or forage.

While the tropical forests diminish in area, the temperate woods have their own problems. The phenomenon known as *Waldsterben*—literally, “forest death”—is blighting the trees of the northern hemisphere. Its causes are still unclear, but it seems to be a combined and devastating effect of pollutants, insects, fungi, and weather. It acts fast. In 1982, 8 percent of West German forests were reported dead or damaged. That rose to 34 percent in 1983, 50 percent in 1984, and 55 percent in 1985 (Reference: Federal Ministry of Food, Agriculture, and Forestry, Bonn, West Germany: *Forest Damage Surveys*). About 25,000 square miles of forests are affected so far, mainly in Germany, Austria, Czechoslovakia, Poland, and Yugoslavia.

In the northern forests of the United States and Canada, the American equivalent of *Waldsterben* is the result of acid rain—something which is a contributor to the European problem, but not the whole story.

“Acid rain” is something of a catch-all term for a variety of atmospheric pollutions. Sulfur dioxide and nitrogen oxides are emitted into the air (largely from power stations), travel a long way from their point of origin, and are chemically transformed in the atmo-

sphere to sulfuric and nitric acid. In these forms the pollutants return as "acid rain"—rain, fog, and dry particles, which kill or damage millions of square miles of the northern forests.

The Europeans are moving toward international agreements to limit power plant and vehicle emissions, using a technology that is already well-established. But the United States and Canada are far from agreement. The U.S. Administration denies that we are polluting Canada with acid rain, a position which I find both preposterous and irresponsible. The culprit here is U.S. industry, which does not want to foot the bill for cleaning up smokestack emissions, and has pressured the government to take their side. (For more on acid rain, see the Office of Technology Assessment's 1985 report, *Acid Rain and Transported Air Pollutants*.)

Meanwhile, the trees die. Before we mock the Africans and Latin Americans for destroying their forests, we ought to look hard at our own actions.

The rate of loss of the northern forests is hard to estimate, since there is also a vigorous reforestation program in Europe and America. I don't think we are running out of temperate forests; however, we are certainly not treating them nicely.

6. *Topsoil*. This one is my personal favorite. Topsoil, when you get right down to it, is nothing more than mud. Who could believe that we might be running out of mud?

Yet the loss of topsoil is perhaps the biggest of today's world resource problems, partly because it is distinctly unglamorous and so has been neglected for a long time. People are slowly becoming aware of the vital importance of that bacteria-laden top few inches of the world's land surface. Whole books have been written on the subject (see, for example, *Topsoil and Civilization*, by Vernon Carter and Tom Dale, University of Oklahoma Press, 1974).

Agriculture and forest clearing are the prime causes of topsoil loss. The loss has been going on for a long

time. The Sahara Desert may be the result of ancient deforestation of the west coast of North Africa, the eroded hills of Greece and Lebanon were once wooded, and the cleared interior of Java used to be magnificent teak forests.

The draining of swampy areas can cause similar problems. In the first half of the seventeenth century, the English brought in a Dutch engineer, Cornelius Vermuyden, to direct the draining of the English Fens. These are an area of a thousand or so square miles of eastern England, which for many centuries had been a low-lying, marshy area. The drained Fens yielded a black, peaty soil, often a dozen feet deep and ideal for agriculture. Unfortunately, the moment the drainage operation was complete, the soil level of the Fens began to drop. Today, most of the original soil has vanished, and a grey, infertile substrate has become the new surface.

The loss of the Fens is a small and localized example of something that is happening in this century on a larger scale. In 1934, a single storm in the dust bowls of the United States' prairies removed an estimated 300,000,000 tons of topsoil. Each person in the country lost more than a ton of soil in a few days—and never knew it. More recently, China has lost an estimated 11 percent of its arable lands since 1957, largely to soil erosion and the spread of deserts. Parts of Central America have lost 40 percent of their productive capacity to erosion.

Can we really run out of topsoil? After all, soil is continuously replaced by the weathering of rocks, so we will never run out completely. However, the total area of arable land can certainly decrease. It is decreasing, rapidly, in many parts of the world. Conservation measures are needed to stem the loss, but conservation ideas are hard to sell in Southeast Asia and North Africa, where living standards are already down at survival level.

The problem is urgent. It must be tackled soon. Otherwise, in fifty years, the clearing of forests, draining of swamps, and overgrazing of rangelands will re-

duce the productive soils of the world to less than one-half of what we have today.

7. *Species*. This is another sleeper. The tropical rain forests are the hiding place of millions of plant and animal species that have not yet been named and cataloged, still less studied. Their properties and potential value are completely unknown, although the gene pool of agriculture has historically been mainly in the tropics and the southern hemisphere, where our knowledge is least (coffee is native to Africa, corn to Mexico, the potato to the Andes, and wheat to Ethiopia).

Although most of the world's food comes from only twenty or so crops, at least 3,000 plant species exist that are known to have good food and fuel potential. They range from the central American *pejibaye* palm, with a fruit almost perfectly matched to the human diet, to the *tepary* and *marama* beans, which thrive in North American and South African deserts, to the Brazilian *bracatinga* tree, which grows fifty feet high in three years. (Reference: "Lesser-known Plants of Potential Use in Agriculture and Forestry," by Noel Vietmeyer, *Science*, 13 June, 1986.)

These plants have been known for many years, but most species of the tropical forests have not yet been the subject of any intensive agricultural study—and one wonders if they ever will be. The tropical rain forests are disappearing—fast—and they are the richest habitat in the world for species diversity. No one knows the total number of species on the planet, but one estimate from *World Resources 1986* is shown in Table 4. Of that estimated total of roughly five million species, three-fourths are found *only in the tropics*. And five million, it must be emphasized, is a *minimum* figure—some research suggests there may be as many as 30 million insect species in the tropical forests alone.

My fear is that millions of species of plants and animals will never prove to be valuable, because they will be rendered extinct *before their value can be established*. We tend to be aware of only the most spectacular and

TABLE 4: Species of the World.

Class	Identified Species	Estimated Species
Mammals	4,170	4,300
Birds	8,715	9,000
Reptiles	5,115	6,000
Amphibians	2,125	3,500
Fishes	21,000	23,000
Invertebrates	1,300,000	4,400,000
Vascular plants	250,000	280,000
Nonvascular plants	150,000	200,000

glaring examples, such as the hunting to extinction of the great whales, but there are thousands of others that we will never know about. Here is a sobering thought: a million species will probably become extinct in the next twenty years. A million is too big a number to have much everyday meaning, but let us think of it this way: a couple of dozen tropical species will vanish forever from the Earth during the few hours that I am writing this article (a million species in 20 years is six species an hour).

We will neither know nor grieve their passing; but I will miss the whales.

A small aside here: I have worked a good deal with Japanese scientists, and have always enjoyed it. The Japanese I have met were cheerful, courteous, smart, and hard-working, and those are the best possible attributes for a fellow worker. But I always have a reservation. I have asked a number of my Japanese colleagues about the continued Japanese hunting of whales, and they universally express disapproval.

But beyond words lie actions. The Japanese government has refused to restrict whaling in a way that permits a species to survive. They will agree to a treaty—when there are no whales left to catch.

I don't accept a view that now seems popular—namely, that the whales are an intelligent species, smarter, say, than the great apes. But they are big, and they are

beautiful, and there is nothing else like them on Earth. Our lives would be diminished without them. The continued remorseless hunting of them shows a dark side of the Japanese character.

Would you like to see a dark side of the American character? Remember, then, that the United States until just a few years ago counted *tobacco* as a food in its foreign aid program. Nice guys, eh?

I'm also tempted to discuss the way that we have signed treaties with the Europeans for joint space activities, and then reneged on them with never a word of apology. (At least the Japanese refuse to sign the whaling treaties.) But I am getting ahead of myself, and possibly beside myself, too. Not a comfortable position.

Back to running out (of resources, not on agreements).

8. *People. People?! Come on, now!* I can hear you already. Surely people are the *cause* of our problems. If we had a lot fewer people, we would be running out of a lot fewer things.

That is certainly the majority viewpoint, and it is also my own opinion. But I want to mention a curious, and curiously interesting, opposite position. You can find it in the book, *Migration to the Stars*, by Edward Gilfillan (Robert B. Luce Publishing Co., New York, 1975). The subtitle of the book is revealing: "Never Again Enough People." One reason that the book is so interesting is that Gilfillan is an engineer, and a good one, who is very well aware of the dangers of running out of resources, and throws in a few danger signals of his own that I have chosen to leave out (for example, excessive radioactivity produced not by war, but by peace). By and large, he warns of the dangers that have been discussed here. However, Gilfillan takes the long view: he argues that humankind will solve the short-term problems that I am concerned with, and survive to become a space-borne and space-colonizing civilization at an interstellar level. When that happens, he foresees that *underpopulation* will be a prime worry. As he



points out, this presents problems just as bad as those of overpopulation.

I find Gilfillan so logical and so persuasive that I would not dream of arguing with him. Instead, I prefer to worry about the "short-term" problem that he doesn't consider much—namely, making it through the next couple of hundred years. I am content to leave the long term to others (for in the long run, as John Maynard Keynes remarked, we are all dead).

Meanwhile, let us look at population figures. It took the human race until the year 1800 to reach a population of one billion. Two billion came by 1930, three billion by 1960. Today the population is about 4.8 billion, with six billion expected by 2000 A.D. By 2050, projections estimate a world population of 9.5 billion, leveling off to a steady-state value of 10.2 billion by 2100.

Those numbers may not alarm the Pope, but they certainly frighten me. Note that the estimate says nothing about the ability to feed and clothe such numbers. That is, in the magic language of bureaucracy, the responsibility of another department. It is a nontrivial responsibility, with eighty million extra mouths to feed every year.

Predictably, the regions of the world where the population is growing fastest are the regions worst equipped to handle the increase. Africa, with a population growth rate of 3 percent per year (which will double the number of people by 2010) has trouble feeding its present inhabitants. The United States, with a growth rate of only 0.86 percent, has food to spare. It is difficult to see anything in the next half century, other than global war, which will narrow the gap between the haves and the have-nots of the world. Whatever else we will run out of, we will not run out of people.

### *9. What can we do about it?*

A number of different dates and danger points have emerged in the discussion so far, but it is clear that by 2040 we will be running low on many resources. More

than that, many of Earth's environmental systems will be strained to their limits. It seems logical to look elsewhere for possible solutions; in particular, we should look to space.

A simple inventory of materials available through the solar system is both greatly encouraging and totally misleading. We can easily calculate that there are ten billion cubic kilometers of water (mainly ice) on Europa and Ganymede, 150 million square kilometers of land area on Mars (about the same land area as Earth), 240 trillion cubic kilometers of compressed hydrogen on Jupiter and Saturn, 800 quadrillion tons of iron in the asteroid belt, and unspecifiable but huge amounts of water, ammonia, and methane out in the Oort Cloud. And we may be tempted to conclude from this that all our troubles are over. When Earth can no longer support us, we will have plenty of expansion room.

Such analyses have led many people (including me) to point outwards to the "endless resources" of space, and conclude without further discussion that the answer to Earth's resource problems would be provided at once by a vastly bigger space program.

It doesn't work that way.

I still believe that space is the right answer—maybe the only answer—but we have to think the problem through. First, let us dispose of the idea that we will soon be growing food out somewhere in space colonies, and dropping great bales of it back down to Earth. It's a nice picture, certainly. The space between Earth and Venus would be filled with vast space farms, to become the breadbasket of the solar system; and perhaps the space between Mercury and Venus would be filled with great solar collectors and energy converters, to become the powerhouse of the system.

I hate to say that it will never happen—the use of "never" is a very good way to be wrong. But I will assert that this cannot be the short-term (i.e., the next few centuries) solution. Neither will we be able to export our problems, sending them with Earth's excess population out into space. That's a race you can't win;

the ones left behind can always breed faster than you ship people out.

The short-term solution is simpler. We will indeed use space to help with Earth's problems, and use it extensively. But we won't create space farms, billions of hectares in area, or space power-collectors, thousands of kilometers across. That is too inefficient. Sunlight is readily available as a source of power, but it is also a very dilute energy source, even if we put our collectors inside the orbit of Mercury. Like windmills, solar power satellites are diffuse energy collectors, an idea whose time has *gone*. All human progress has moved toward more compact sources and higher energy densities. Why go to the trouble of building vast arrays of sunlight collectors, when we can generate the power from a square kilometer of sunlight in a fusion unit the size of an automobile? Of course, we can't do it today, but we will certainly be able to do it a century from now.

That's what we will put in orbit—our fusion power stations. The waste heat problem that is such a nuisance here on Earth, and causes us to use so much of our fresh water as power station coolant, is no problem in space: waste energy can radiate outwards, to heat the whole rest of the universe.

The raw materials needed to make the power stations will also be collected in space, from asteroid sources initially. The power to process them to manufactured forms comes from the same stations, in a bootstrapping procedure that uses power stations to process more materials, and more manufactured materials to build more power stations. The power needed here on Earth to recycle our water supplies, or form the fertilizers for our agriculture, will be sent down from space—perhaps as microwaves, which is a form of technology available today, or perhaps at some other wavelength.

None of these things will happen easily. If mankind's historical unwillingness to face problems before they are critical is any guide, we will leave space development to the last possible moment. However, we may already be at that moment. Our critical point, the year

2040, is awfully close, and there is a lot to be done. We must provide a transportation vehicle that permits low-cost access to space; we must explore the most accessible asteroids, to determine their detailed composition; and we must establish a space infrastructure that allows and encourages commercial enterprise. In a sentence, we must create a *policy for space development*—something this country has never had, and shows no interest in having. Today we have an Administration and a Congress that is long on posturing, and short on commitment to space. Changing that will be no easier than solving the problems of soil erosion, water and air pollution, energy shortages, population growth, deforestation, or species extinction. However, solving the space program problem is perhaps the key to solving all the others.

And if we are successful, what will happen to Earth itself? It can become again the garden of our dreams, the fertile Eden that existed before exploitation, industries, and energy needs darkened its face. This planet will again be the home of people, plants, and animals. Power stations and heavy industries will move to space, and the idea that they might reside *here*, next to us and our food supplies, will become an unthinkable one—as primitive and unacceptable, to our great-grandchildren, as allowing a privy to drain into a well.

*Introduction to*  
**DO YOU REALLY WANT A BIGGER  
U.S. SPACE PROGRAM?**

*On the other hand, Dr. Sheffield's reasoning is so profound, so cogent, that it is quite possible to conclude that it is the previous piece that is the, ahem, Red Herring. Maybe he should be lynched . . . (But not, of course, your Humble Editor, whose job it is to see that all voices are heard . . .)*

# **Do You Really Want A Bigger U.S. Space Program?**

*Charles Sheffield*

**Flexible morality.** Is it wrong to cheat on your income tax returns? I'm not thinking about large-scale wrongdoing, but of estimating deductions always a little on the high side, or failing to report small items of income. Is that wrong?

Wrong or not, polls suggest that three people out of five cheat in this way, and the other two refrain mostly because they are afraid they will get caught. When you ask the question, "Would you cheat on your income tax if you were completely sure that you could do it without the IRS finding out?", ninety percent of us say that we would (and we probably believe that the other ten percent are lying).

Stealing from the government is apparently not "wrong" in the usual sense. A recent survey of tele-

phone use within selected Government agencies showed that from 20 to 33 percent of *all* long-distance telephone calls made by government employees were for personal business—even though this is explicitly prohibited by federal law. And these calls were presumably made on government time, when the employee was supposed to be working, so they were illegally charging for their time, too. Yet most of the people who made those illegal phone calls would object strongly if you told them that they were criminals. They don't *feel* like criminals.

Far fewer people are willing to steal from friends and family, even when the chances of the theft being discovered are negligible. There is a general principle at work here: "The degree of wrongdoing in theft is considered to be inversely proportional to the size of the organization being robbed."

Steal twenty dollars from the government, or the telephone company, or a big insurance company, and you can still sleep soundly at night. Steal one dollar from your neighbor, or a small store, and you suffer pangs of conscience.

We can distinguish three processes of self-justification for such actions. The first employs the *Principle of Dilution*. It argues that twenty dollars is a negligibly small part of government or phone company revenues of many billions of dollars. When the twenty dollars that you cheat on your taxes is spread over two hundred million people, what you have done costs each of them only one one-hundred thousandth of a cent. On the other hand, the dollar you steal from a friend goes right out of his pocket and into yours.

The second justification expresses the *Principle of Impotence*. It shows the individual's resentment at a lack of control over big organizations. It is expressed every time you hear someone say, "Look at that dumb government project! What a terrible waste of taxpayers' money!" or "My phone bill is way out of sight these days. The phone company must be making tremendous profits, and there's not a thing I can do about it. If I

cause any trouble, they'll just cut me off." Everyone has read horror stories of a family being billed by the gas company's computer for ten thousand dollars, with service then cut off automatically because they did not pay.

We are all uncomfortable with large, incomprehensible organizations with unreachable management. This discomfort turns to active dislike or hatred when those organizations have power over our lives. (There is nothing new in this attitude. Fifty years ago, A.P. Herbert was writing, "Fancy giving money to the government! Might as well have put it down the drain. Fancy giving money to the government! Nobody will see the stuff again.")

As institutions have grown bigger and bigger, the feeling of impotence and loss of control by the individual has increased with it. Anyone who has attempted to get direct answers from a large government agency knows the feeling. It is quite easy to be bounced around a dozen different departments, sometimes in a complete circle, and not be able to *do* anything.

The third justification of cheating is the simplest of all. It is the *Principle of Equivalence*. "Everybody else does it, so I have to do it. If I *didn't* do it, I'd be paying more than my fair share." If everyone else indeed cheats on his income tax, cheating on your part is a perfectly logical and valid response. It is also, of course, an illegal one.

It is wrong, too. If the law is stupid, the easy answer is to break it. The right answer is to change it. Unfortunately, that leads us right back to the Principle of Impotence. Changing federal law, like anything else at federal government level, seems beyond the power of the individual.

This is why citizens' interest groups are so popular. If one person's opinions are too diluted to be noticed, perhaps the opinions of five thousand people acting together *will* be noticed.

**The size of the United States Space Program. The**



amount that the United States spent on its civilian space program peaked at five billion dollars in 1965, dipped to a low point of three billion in 1974, and is now up at seven billion. However, this picture is misleading unless it is corrected for the effects of inflation. When we make that adjustment, we find that in terms of today's dollars the NASA budget peaked in 1965 at about fifteen billion, declined to seven billion by 1974, reached its low point in 1982, and is now again close to seven billion. We spend less real money on space today than we did twenty years ago.

Seven billion dollars is about thirty dollars per person per year, far less than the 1,000 dollars per person per year that we spend on defense. But is it too much, or too little?

Naturally, most space enthusiasts argue that it is far too little. They point out, quite correctly, that Americans spend as much each year on pizza as on space, and far more on illegal drugs, alcohol, and cigarettes. People who don't like the space program respond that at least an individual decides for himself what he will spend on food, drink, and tobacco, whereas the contributions to space are extracted unwillingly in the form of taxation.

Polls concerning the space program provide very mixed signals. On the one hand, they show that the program has high visibility and popular acceptance. People like to see successful results of our hi-tech activities. Even in the dark days that followed the loss of the *Challenger* crew and the intensive questioning of NASA's professional competence that went with it, the National Air and Space Museum remained America's best-attended museum. On the other hand, when the American people are asked to rank different areas on which money should be spent, space finishes far down the list, well below defense, education, crime prevention, and environmental protection. The general message might be interpreted as, "We like space development very well—but we don't want to pay much for it." If there is a "right size" for the space program, we won't find it from the polls.

Most people are amazed when they find out what a small percentage of the Gross National Product goes to space activities, but even when they do know, they are hard pressed to suggest what *should* be spent.

What is an "appropriate" amount? Let us approach the question using general principles.

**Limiting cases.** No scientific problem involving the physical world is ever solved exactly. All we have are exact solutions to simplified problems, and approximate solutions to real problems. (Social problems are even worse—we rarely have solutions of any kind, exact or approximate!)

One widely used scientific method of making a simplified problem that we can examine, and perhaps solve exactly, comes through the construction of *limiting cases*. For example, in statistics we are often interested in some property of a population, say, the percentage of people who smoke, or own cars, or are under six feet tall. The human population is of course finite, but it is very large, and it is usually easier mathematically to deal with the statistical properties of an infinitely large group. We therefore derive the properties of the limiting case of infinitely large numbers, and employ the messier mathematics of finite populations only when we are obliged to, because the group we are studying is small. How many left-handed zoo-keepers over the age of forty drive Buicks? I don't know, but I think this is a case where our sampling methods need the statistics of small populations. How many American males watch football on Sunday afternoon? Again, I don't know, but in this case I would be very comfortable using sampling methods appropriate to an infinite population.

In the same way, from a gravitational point of view the whole Solar System is one complicated coupled system, where every body acts on every other. But we can get useful results by looking at limiting cases. For example, as one limiting case we are able to solve exactly for the motion of a single planet moving around the Sun. Then

we can treat the effects of other bodies of the system as small perturbations to our known solution.

The decision to study a limiting case is often made almost unconsciously by the scientist and engineer. When we calculate the way that a beam bends under an applied load, the idea that it is composed of a large number of small individual particles (atoms) simply never arises. We solve for the limiting case of infinitely small and stable atoms. It is only when we are looking at ways in which the beam will *break* that we are forced to consider atomic lattices and small-scale departures from perfect regularity.

Given the great success of limiting cases in problems of science and engineering, let us see if we can get anywhere applying the same principles to social and political questions; in particular, can we decide the right size and structure for the U.S. space program, within the social framework of this country? Let me warn the ardent space enthusiasts that they may not like the results.

We will begin with three political limiting cases. We will not ask ourselves initially whether they could ever be implemented in a working system of government.

*Limiting Case 1: Zero taxation.* In this case there are no government taxes of any kind, and thus no agency responsible for collecting them (already I hear cheers). Everyone takes home every penny earned. Publicly funded projects, such as national defense, welfare for the indigent, education, and space development, are supported by *contributions*, just as charities and religions are supported today. Every year, each person decides how much the space program or national defense is worth to him personally, and sends a check for that amount, earmarked as to use, to a central bank responsible for taking in and passing on the money. There is nothing to prevent an individual making a multi-year pledge to a particular program, but also nothing requiring it. Projects that fail to obtain contributions from the public simply disappear.

I know of no example of a society that employs this

limitating case, or anything close to it. But before discussing it further, let us define a second case which lies at the opposite extreme.

*Limiting Case 2: Total taxation.* In this case *everything* that a person earns is paid to the government. The government decides completely how the money will be used. In return for working on government-approved projects, a person is given money to live on.

Such a system raises an immediate question: if everyone works on government-approved projects, then everyone is part of the government. So who decides which projects will be approved?

This limiting case is ideal communism. Again, I know of no society that employs it.

*Limiting Case 3: Absolute despotism.* Here all power and property sits in the hands of one person. Anything that anyone else possesses has been granted by the ruler and can be taken away by the ruler.

This system is hard to find in the world today, but it has been popular through history. China has had more than its share of absolute rulers, beginning with Emperor Qin in about 250 B.C. After he died in 210 B.C., the society he had built collapsed within a few years. Absolute despotism has particular problems at the time of succession of rulers.

Note that absolute despotism can evolve easily from ideal communism. The state already owns everything, so all that is needed is for one person to become the single point of power in the state government. It was easier for Stalin to attain absolute power in the Soviet Union than it would have been in the United States.

Despotism also answers the difficult question of deciding on the "right" projects for a nation. "L'Etat, c'est moi," said Louis XIV, and nobody was going to argue with him.

Conversely, the collapse of despotism often leads to communism. If we put our limiting cases along a single straight line, we find that Limiting Case 1 sits at one extreme, with Limiting Cases 2 and 3 at the other, essentially indistinguishable from each other. I argue

that despotism and communism are socially and politically close, because one can turn easily into the other without any real change in the way that a nation functions.

Before moving on, let us note a few options that lie somewhere between the extremes of our limiting cases. One of these is in use in the United States today. Taxation levels are set by the representatives of the people, and the way in which the tax revenues are spent is decided by those same elected representatives. Should tax levels become very high, we move away from Limiting Case 1 and towards Limiting Case 2.

Another possibility, and one that has been seriously proposed as preferable to the system we have in this country today, sets taxation levels through the House of Representatives. However, the taxpayer then has the right to earmark his actual taxes to certain government programs, and to deny the contribution of taxes to other programs. A more realistic variation on this system would allow the taxpayer to assign some percentage of all taxes collected by the government on a discretionary basis, with the rest assigned by the decisions of the people's representatives.

I don't think we are likely to see such a system, no matter how desirable we may think it is. Allowing the taxpayer to make personal decisions on the use of taxes takes power away from the men and women elected to the House and Senate. The change to such a new system would have to be made through the actions of that very same group of people. Human nature being what it is, don't look for laws that permit direct taxpayer involvement at the expense of Congressional power.

**Stability and long-term goals.** The development of space will not be accomplished in a year or two, or even in a generation or two. We are therefore obliged to think of social structures for the long term.

It is not enough to set up a political system adequate for today's needs, if that system will survive for only a

short time. The dream of anyone who is present at the birth of a social system is that it should *endure*. Hitler claimed explicitly that he was establishing the Thousand-Year Reich. The American Founding Fathers were less grandiose in their ambitions, but they certainly had their hopes. When Thomas Jefferson spoke in his inaugural address of "the preservation of general government in its whole constitutional vigor," he was clearly hoping that the Constitution of the new United States would be a lasting document for government. (He called in the same speech for "a wise and frugal government . . . which will not take from the mouth of labor the bread it has earned," but if we pursue that theme we will never reach the end of this article.)

Enduring, in the physical sciences, is a sign of the *stability* of a system. Stable systems persist. Unstable systems quickly move to a different and more stable configuration. There are two sorts of stability that we will consider here:

1) *Intrinsic stability*. Starting from any reasonable distribution (of, for example, capital or goods), will the society remain close to that, or will it quickly diverge to a point where it is soon unrecognizably different from the way that it began?

A system that rapidly evolves from its starting point to a grossly different situation is not to most people's taste.

2) *Stability against external perturbation*. Could some small applied change, natural or man-made and applied from without, cause very large changes to the state of society?

Although we have good practical evidence that the system of taxation, government, and people's representation as it exists in the United States today is fairly stable, it is much too complicated to be *analyzed* for stability. However, this is precisely why limiting cases are useful. They can be solved, or at least analyzed, where more realistic models cannot. Even if we then decide that they do not represent a close approximation to the functioning of any nation in the world today,

they serve to stimulate thought; often they also tell us what new variables must be introduced into the analysis to make it more realistic.

**Space programs in limiting-case societies.** Neither the United States nor the Soviet Union possesses a system of government corresponding to the limiting cases discussed earlier. However, it is fair to say that the United States is a society closer to Limiting Case 1 (zero taxation—don't read this on April 15th) than the Soviet Union, which approximates Limiting Case 2 (total taxation). For purposes of comparison, we will examine the status and growth of space programs in these two different limiting cases.

Let us focus on three main properties that we can associate with a successful space program, and see if they are present in our two limiting cases. Any good program needs, at a minimum,

- 1) adequate funding,
- 2) continuity of effort, and
- 3) strong supporting technology.

The Soviet Union was first into space (with Sputnik 1), first to fly past the Moon (Luna 1), first to hit the Moon (Luna 2), first to soft-land on the Moon (Luna 3), first to land on Venus (Venera 3), first to return photographs of Venus (Veneras 9 and 10), first to land on Mars (Mars 2), first to send a man into space (Yuri Gagarin), first to send a woman into space (Valentina Tereshkova). Against this string of accomplishments, the United States can set the first men to reach the Moon (and the *only* men to reach to Moon); the first Mars Lander; the great successes of the unmanned exploration of the Outer System, from Pioneer to Voyager; and the development of the Space Shuttle, the world's first partly reusable spacecraft.

Despite the ballyhoo surrounding the proposed U.S. Space Station, both the United States and the Soviet Union have had space stations for a long time. Skylab was a large space structure, a space station that was used only in 1973 and 1974, but which had the poten-

tial to be still in regular use today. The Soviet Salyut-6 and -7 spacecraft are space stations, with over fifty thousand man-hours of cosmonaut occupancy since the 1977 launch of Salyut-6.

Both nations clearly have much to be proud of. But when we compare the nature of their programs, big differences begin to emerge. The Soviet Union has consistently employed to the full its *existing* technology, preferring the old and tested to the new and exploratory. The United States allowed the proven capability of the Saturn series of boosters to be lost, while the new and experimental Space Shuttle was still in its early development. In the same way, as soon as the Shuttle was flying, pressure was applied by OMB (with NASA's blessing) to reduce the number of expendable launch vehicles. This led in 1986 to the unfortunate situation where the Shuttle was grounded, while adequate expendable launches were not available as an alternative. Meanwhile, the Soviet Union carries on with regular launches using old but effective boosters, and slowly develops more powerful vehicles.

This pattern of behavior is characteristic of the space programs of the two nations. The Soviet Union has a long-term commitment to space development, but lacks the United States' technological strengths, particularly in the fields of electronic components and computers. The United States bursts with innovation, while failing to make best use of the technology it already has.

(It is arguable whether the Soviet Union will ever experience the huge growth in the use of personal computers that this country has seen in the past five years, complete with computer games, networking, bulletin boards, and data swapping. Access to information, and the exchange of information, is tightly controlled in the Soviet Union. The Party there faces a difficult choice: allow the growth of computer use, and with it an increased access to information by the people; or restrict computer use, and see their nation fall steadily farther behind the free world in technology development.)



On the other hand, there has been a continuity of effort in the Soviet program that is sadly lacking here in the U.S.A. In order for a new space mission to be funded in the United States, it has to be excitingly new (the Shuttle, in its development days); of incontestable value (the weather satellites—and even here, there is each year an attempt to strike the second polar orbiting weather satellite out of the budget); or outside the government appropriation process (communication satellites). This funding process produces a stop-and-start national program which is an absolute disaster from the point of view of personnel morale and efficient use of capability.

In summary, the Soviet space program leads in two of the three areas, adequate funding and continuity of effort; the United States program leads in the third area, of strong supporting technology.

Suppose that the United States employed a pure Limiting Case 1 process for funding its space program. Set aside for the moment the question as to the total amount of money that would be collected for public programs in a system of purely voluntary contributions. Presumably the economy under such a Limiting Case 1 taxation system would still be subject to its ups and downs. Predictably, when the economy is depressed, people are less inclined to contribute to the support of public programs, including space. Thus Limiting Case 1 leads to a situation in which public spending is tied directly and immediately (or with at most a few months' lag) to the state of the economy. Any dissatisfaction with today's stop-go funding for space development would be compounded in a Case 1 society. When we lobby for a guaranteed, well-funded, continuous Space Program, we are implicitly proposing a move away from Limiting Case One, and towards Limiting Case 2.

Conversely, look at Limiting Case 2. The economy will have its strong and weak periods, and the total funding available to the government will fluctuate. However, in such a situation it is the consumer—the private citizen—who typically suffers during times of depres-

sion. The public programs, such as defense, space (which in the Soviet Union is a military program), and energy, are buffered against the ups and downs in the economy. They have first call on the nation's resources. The Soviet Union, which approximates a Case 2 society, has certainly had its economic setbacks in the past decade, and sometimes the country's whole economy seems close to collapse; you would never know it if you looked only at the number of spacecraft launched by the Soviets.

Limiting Case 1 societies, by definition, cannot have *guaranteed* continuity for any public program; Limiting Case 2 societies can force continuity of any chosen program, as part of government policy. The United States is closer to Case 1 than Case 2. If we want to *assure* the growth of the space program, we should therefore move the United States farther along the line, away from Limiting Case 1 and towards Limiting Case 2.

This is an embarrassing conclusion to anyone who feels that a strong, continuously-funded United States space program is part of an outward-looking, expansionist philosophy, consistent with a free-enterprise system that minimizes taxation and maximizes individual choice.

It is also an unpalatable thought. People who have been working hard to make our space program grow through political activism don't want to hear that the price of success may be a move *away* from free enterprise.

There is an equally unpalatable second conclusion. If we move towards Limiting Case 2 to stimulate a stronger space program, the same action will damp the rapid development of advanced technology. We have already seen that advanced technology blossoms in this country when private capital investment is most and government controls least.

Well, perhaps my conclusion is wrong. Let us look at possible objections to it. The first is a practical one: even if this country moved towards Case 2, how could we be sure that space would be one of the government's priorities? I cannot answer this question, except

to observe that space expenditures *considered as an element of national defense* would almost certainly increase.

The second objection is more general. I have assumed that societies all lie on the line joining Limiting Cases 1 and 2. This is clearly an oversimplification, and there may be other ways to space—through societies that are “off the axis” and provide a completely new approach.

For example, what about the idea that the right way to space is through privately-held companies, moving us off Earth without being part of any government program?

Sadly, experience in this country and Europe suggests that this road is too difficult and expensive to be travelled today. Government funding is a *sine qua non*. Space Services, Inc. and others in this country, and OTRAG in Germany, tested the willingness of private capital to invest in private launch vehicles. One million dollars, or even ten million dollars, is easy to raise. A hundred million is far more difficult, and several billion is flat impossible.

How about an international space consortium, similar to Intelsat but including all space activities, rather than just communications?

We already have one such in the world: the European Space Agency. This country, however, shows no inclination to merge NASA with ESA, nor is ESA rushing to invite us in (the U.S. has already reneged on several major joint programs with ESA, much to the annoyance of the Europeans). Cooperative efforts with the Soviet Union, much discussed in the context of a joint manned mission to Mars, have no political reality.

How about a grass-roots movement, working country-wide to persuade the U.S. citizenry of the value of space? This was, after all, a method that worked to make people sensitive to the degradation of the environment.

We have one of these, too. A number of the pro-space organizations strive mightily to provide space-related information and education, to work with local

and national politicians, and to mobilize letter-writing and telephone calls on critical issues. The size of our *existing* space program therefore already reflects these efforts. To double the size of the grass-roots effort is a formidable task, as anyone involved in the National Space Society will readily tell you. It is also difficult to measure the impact of the existing efforts. The amount of money spent by this country on space often seems to be decided by levels of international tension and military needs. On my less cheerful days, I feel those of us promoting space are like the fly in Aesop's fable, sitting on the axle of a moving chariot and remarking what a lot of dust we are kicking up.

Overall, I see nothing to make me change my mind about my original conclusion. If we want to make the U.S. space program bigger, and have no other concerns, we should move the country farther along the society axis, towards Limiting Case 2 and away from Case 1.

**Unpopular thoughts: stability and morality.** A move along our society axis cannot be the whole story; we have made no allowance for the stability of different structures, and we do not want to find ourselves with a less stable society as the price for a stronger space program.

I want to advance a general theorem of stability of societal structure, and verify it at least to my own satisfaction by general arguments (I suspect that any real proof I attempted would make professional economists blench).

*Theorem:* Let  $T$  be the total fraction of earned income paid in compulsory taxes. Then societies employing Limiting Case 1 ( $T = 0$ ) and Limiting Case 2 ( $T = 1.0$ ) are both unstable; both forms will regress over time to a "mixed state," with stability possible when  $0.15 < T < 0.60$ .

Consider Limiting Case 2. Since an individual earns no direct reward for work performed, there is no incentive to work harder, and plenty to loaf (the Principle of

Equivalence: everybody else is doing it, so I should). There are also, for most people in a Case 2 society, Principles of Dilution and Impotence that makes anything we have in this country look mild. The average citizen can make a difference to nothing. *Everything* is government, and everything is beyond individual control. Personal efforts cannot influence policy, or produce noticeable changes.

In such a situation, people look for ways to earn money that is outside the system and therefore tax-free. In the Soviet Union, black market and barter economies thrive. In China, the government in recent years has recognized the importance of personal earnings, and has introduced a local form of capitalism that overlays the country-wide communism. This additional income is not taxed—and the resulting recent growth in Chinese production has been astonishing. Human nature being what it is, individuals will always try to better their lot. In a country of total taxation, people look for other tax-free ways to generate income. Society, without necessarily admitting it, drifts away from the limiting case of  $T = 1.0$  to a system admitting private enterprise. The inherent instability of  $T = 1.0$  in today's world is added to by external influences. For example, knowledge within the Soviet Union and China of the freedom and high standard of living in the West leads to discontent, and nudges these countries towards free enterprise.

Experience in Europe with high tax rates suggests that motivation to work and earn money diminishes when  $T$  is more than about 0.6. At this point employers are obliged to look for other ways to attract valuable workers (in the form of tax-free "perks" and stock options). Therefore we expect barter and other private enterprise methods to grow until they are at least 40 percent of the total revenue base of a country.

On the other hand, consider a Limiting Case 1 society, where  $T = 0$ . In addition to its obvious function of raising capital for public projects, taxation has a very important secondary effect: it is an instrument for the

re-distribution of income. This is at its most obvious in the case of death duties, where the state helps itself to a substantial fraction of a dead man's estate (or more likely a woman's estate, since wives tend to outlive their husbands). In a society where everyone has a vote, but there is no taxation, there will be a tendency to pass legislation favoring redistribution of wealth. This will be done through taxation (so  $T$  is not longer equal to zero). It continues until a point is reached where the majority of people are adversely affected by further redistribution. If legislation goes past this, we see political pressure for tax cuts. Experience in this country suggests that the crossover point is between  $T = 0.15$  and  $T = 0.3$  (I'm including the effects of *all* taxes here, including state tax, sales taxes, duties and tariffs). I believe that any political effort promoting taxation outside this range in the United States is bound to fail.

With today's tax rates in the United States we are certainly nowhere near the limit of stability. Even the largest tax increase we can imagine as plausible would not lead to an unstable society. Therefore it is not dangerous to seek the increase in public spending that would be needed to boost our space program investment substantially. But would it be *right* to do so?

Much as I like and value space development, I think that an expanded U.S. space program achieved through a general increase in taxes and public spending would be wrong. I also question the morality of any intensive campaigns to "sell space" to the American people, or to promote space through political pressures. The justification of such methods again draws on the Principle of Equivalence ("Everybody else is scrambling for funds, so if we don't get tax money for space, it will go down the drain somewhere else") and on the Principle of Dilution ("What's another billion for space?—it's only a few dollars per person.") But even when both these statements are true, they are not sufficient grounds for an enlarged effort in space.

My earlier worries regarding flexible morality apply just as well when we are taking money from the system

as when we were putting it in. If it is wrong to pay less than your share, it is just as wrong to take out *more* than your share to fund your own favorite projects. This is pork-barreling, and it is rightly condemned even when widely practised by Congress.

The United States space program deserves to prosper if and only if it produces demonstrable returns to whoever is footing the bill. Today and for the foreseeable future, "whoever" means the American taxpayer. The American people have not yet been persuaded that the returns from space are real and substantial; and until people *want* to spend more on space, and public opinion polls make that fact clear, it is immoral to try to obtain large new funds for space by political pressure.





*Introduction to*  
**THE DREAMING SPIRES OF HOUSTON**

*If the combined vectors of the previous two pieces point to puzzlement, this one's aim is straight to—and from—the heart. Indeed, some may claim that the author has committed an act of Literature.*

# THE DREAMING SPIRES OF HOUSTON

*Charles Sheffield*

It was winter when I left Washington—eight inches of snow on the ground and no sign of a thaw. We flew southwest. The touchdown in Houston was so late that I was blind to temperature and everything else on the midnight journey along Route 45. Not until the next morning, when we drove in through the South Gate of the Johnson Space Center and were waved on by the guard, did my senses open to the change. It was spring here—heady air, the smell of damp grass.

Our meeting was in Building 17—eleven hours of artificial lighting and hard argument. When we came out it was already dusk, a soft and blue and warm dusk, with Venus setting to the west and Jupiter (the wooden star, the Chinese call it) rising in the east. I walked slowly toward the car, and felt my own spring stirring within me. It was the moment in the year when sap flows and the sources of internal energy are renewed; perhaps old age is defined as the day when the spring

sun can no longer call the spirit. I wondered how an aging tree feels, when the spring juices thrust upward, firing irresistibly along old veins.

During the next day the spring weather moved on. Soon it mimicked high summer, with dazzling sunlight and noon air like a breath from a steam boiler. The buildings were intolerably hot, but this was a government facility: the time of year for air conditioning was set by rule, not logic. Sweat trickled down our faces and left damp patches all the way along our backs.

We had turned from contract argument to technical analysis. I would have sworn that all my attention was inside the room, fixed on the discussions, but some little piece of me must have been elsewhere, because in the middle of a talk on multistage sampling methods, I looked out of the window across the flat prospect of the Center, and was transported instantly to another time and place. To the Plain of Holderness, in England, as it was in my childhood forty years ago. Texas became Yorkshire. The rockets near the South Gate stood lazy in the sunlight, rising from the black tarmac like the spires and steeples of a Humberside village, built by my great-grandfathers to watch over the flat, fertile earth and dream the centuries away.

I could see the smaller rockets, and in front of them, through a low line of trees, the hulking stages of a Saturn-V, stretched horizontal. That sight haunted me for the rest of the day. Through the heat haze and humidity, the upright rockets were as graceful and mysterious as minarets.

When we left the building, the dusk of late afternoon was already well advanced. I left the others and headed on foot toward the South Gate.

As I approached the launch vehicles, darkness moved forward a pace. Although the air was still warm, I could no longer tell if the passing cars were blue or red or brown. The black and white trim of the rockets was beginning to blur to a single outline, and the dark Saturn-V sprawled its length along the ground, like Milton's Satan, a Titanic bulk extended long and large.

I sat down under the rolling barrel curve of the Saturn's first stage, and let my mind wander free.

The sun was gone. The temperature dropped sharply. In five minutes, it had fallen five degrees. The silhouettes around me began to sound the creak and twang of cooling metal and shrinking struts. Ten minutes more, and the mutter was louder, emerging from the background of a freshening evening breeze. The rockets were talking, and at last I could understand their utterances.

"Has everyone gone?"

It was the voice of Mercury-Redstone, the shortest and slimmest of the three. Her thin nose was pointed straight up in the air.

"Mm. I *think* so."

That was Saturn. To him, a solitary human hidden away beneath his vast flank was no more than a fly—especially if a man were willing to sit silent, not patting the metal panels or trying, like some of the wretched day visitors, to climb up into the engines.

"What do you mean, think so?" said Mercury sharply. "Can't you tell who's there? You're the lucky one. You ought to be able to see what's going on on the ground."

Saturn did not speak at once, but I heard a deep groan from his lateral braces. He alone of all the rockets had been mounted horizontal. Worse than that, he had been dissected—cut joint from joint to display the engines of each stage, and then stretched piecemeal for nearly two hundred yards along the level grass. He bore his racking patiently, with little complaint.

"You've no idea how dull it is standing here," went on Mercury peevishly. "All I ever get to see are sun and cloud and stars."

"Not true," said Saturn softly. "You see the Moon, too, every night."

"And I'm not getting any younger," she went on. "My sensors aren't good any more for long distances. I just wish I could see straight down now and then. There were people here today, and I could hear them

and feel them, and I feel sure they were doing something horrible to my base—but I couldn't make out what it was."

"What time was that?" Little Joe spoke for the first time. He was squat and sturdy compared with Mercury, and his voice was patient and thoughtful. "We had so many people near us, hundreds of them—I think they were school parties."

"It was in the hottest part of the afternoon, whenever that was. I swear I could feel my paint flaking away. When are they coming to do maintenance work on us? We all need attention, and it's overdue."

"Not for a while. I hear the budget is tight everywhere except the work on the station. We'll be lucky if we even get our trim painted this year."

"Then they shouldn't allow people in to mistreat us. Do *you* know what they were doing to my base?"

"I do," said Saturn. "Two children were trying to cut a piece off to take home with them." He gave a creaking, graveyard chuckle of thermal contraction. "Isn't it nice to be so popular with the kiddies?"

"From my *skin*! The monsters."

"Sure. For a souvenir, to prove they visited the space center, and saw and touched us."

"That's an outrage." Mercury had one thing in the world that she was proud of above all others, but in close second place came pride in her slim lines and perfect shape. "I've a good mind to—to—"

"To what?" Little Joe laughed. "Fly away and leave? If it hadn't been for one of the engineers stopping them when he came by on his lunch break, they'd have had bits of all of us. It's the price of being famous."

Mercury shivered. Her white paint had faded from an evening blush of pink to a lighter dark against the night horizon, and her nose sought out the first stars.

Saturn rumbled his next remark through his massive first stage, striking frequencies too low to resonate in Mercury's slim steeple. "Now, Little Joe, you should know better. You know she always gets upset when the souvenir hunters are about. She's more sensitive than

we are, she's smaller, and there are less spares in stock for her. She'll be gone forever unless she gets protection."

"What are you talking about, Saturn?" said Mercury sharply. "It had better not be about me, I'm warning you. You know those notes are too low for me to catch. Speak higher up."

"Sorry. It wasn't anything important. I was just asking for news, wondering if you or Little Joe had picked up anything interesting today."

News was a chancy thing, collected from the casual talk of visitors and passing staff. "I did," said Little Joe. "They were talking again about the accident. It'll be years before they do any more launches, by the look of it. I just wish we could do something to help." He had been a humble worker for so many years, testing new equipment and ideas, that it was doubly hard for him to accept that he now had no role to play.

"Do they know what it was yet?"

"Boosters, by the look of it. Definitely not in the Orbiter."

"Ah." Saturn gave a chuckle of satisfaction, a deep thunder in the expansion chambers. "Now that's one thing they could never say about me, no matter what else they said. My engines were always rock-steady. They were *reliable*."

"I always said that Columbia and the rest of her clan didn't look right," said Mercury quickly. With her dubious record, she hated to get into any discussion of engine performance. "I mean, I'm very sorry to hear that they're all in such trouble now—but what do you expect? They're such misshapen oafs, they don't look like real rockets at all. You've seen them—boosters and tank and orbiter all tied together like a bundle of old sticks. It's a miracle that any of them ever got into orbit."

"Don't say that, Mercury." Saturn's voice was stern. "Sure, the shuttles are funny-looking, but they're rockets all right, just as much as we are. It's a pity we're not more like *them*. Maybe if we were, we wouldn't be stuck here in this place."

"I could have been like them," said Little Joe stolidly. "In fact, if they'd just try me now with the new fuels, I bet I'd do better than they do."

"No, Little Joe." Saturn sounded gentle and resigned. "You couldn't take it. I've heard the new specifications. You should listen more to the engineers. With those temperatures and stress factors, we'd be gone in a minute. Even me. I'd blow apart like a cloud top with those internal pressures. We just weren't built for it."

"It's easy for them." Siding with Little Joe, Mercury changed the attack. "They have such good materials to work with. Why, I remember when I first began to fly, back long before the two of you were born." Little Joe and Saturn groaned together, a two-toned hum of vibrating side panels. They had heard those words before. Mercury never let anyone forget who had been there first. "Back in those days," went on Mercury, "we couldn't even get ourselves into orbit! Do you know what I managed with my first all-out effort? One hundred and fifteen miles! And I was delighted to do that, and get my payload up and down in one piece."

"But you had only one rider," added Saturn. He wasn't going to let her forget that—he who had thrown teams of men to the moon and tossed whole houses into space.

"One rider. But they were the best, my riders. Even you have to admit that mine were the bravest and best that ever were."

"Let's not get into that argument again," said Saturn. "You know we'll never agree."

The three sat silent for long moments, each with his own thoughts. There had been many shared moments of glory and disaster, but it was the differences of detail in individual memories that lit up the past with its brightest moments.

At last Little Joe sighed. "They're *all* the bravest and best. And now they're in trouble again. So why are we here?"

The others stirred uneasily in the breeze. "What do you mean, Little Joe?"

"If they're in trouble, why do they leave us here in Houston, instead of taking us over to the Cape? We've got more experience between us than all the rest of them put together. We could tell them everything that's likely to happen when you test a new piece of equipment. It probably happened to at least one of us, long ago. I mean, we could be really useful. It's all right me and Mercury laughing at the Shuttle, and saying she and her sisters look like a bunch of old sticks. But she can't help the way she looks. Poor, stubby thing." (This from Little Joe, stumpier and lumpier than anyone!) "Sometime they'll be trying her for orbit again, and we'll all wish her well then. Wouldn't you like to be there, to see her when she goes back up?"

"If she *gets* to orbit," said Mercury spitefully.

"I've told you before, Mercury, you must never talk that way." Saturn's voice was angry. "If any one fails, it's bad for all of us. Remember, the Shuttle was built based on all our experiences. You ought to be more sympathetic—just think of your own first few tries."

Mercury quivered like a landing javelin. "No, thank you. I'd rather not. Lordy, that carries me back. You two are lucky—you never blew up on live television with half the world watching. That's something that Shuttle and I have in common, at least. I still wonder why we don't make our flights with a little more privacy. It's positively indecent, the way we're asked to risk our necks in public, and work with cameras stuck all over us. No privacy at all! And it doesn't matter whose fault it really was, guess who gets the blame? Us. People don't bother to think that we're dependent on computers and communications and fuels and sealants and materials and people. No, if anything goes wrong, it's always *our* fault. So why don't we do it the way some other countries do? You don't see *their* failures plastered all over the newspapers and all over the television news."

Little Joe sighed, this time even more deeply. Over the years, he and Mercury had had hundreds of arguments about the best way to do things, and no one had



been persuaded. Now she seemed to be hardening her views to the point where it was useless to reason with her.

"Look, Mercury." Little Joe couldn't persuade her, but he also couldn't stop arguing. "If you were in one of those other countries you admire so much, do you know what would have happened to you? In Russia, they'd have ground you up long ago for scrap metal—there'd be not a thing left of you."

"How can you even *suggest* something so horrible!"

"It's true, and you know it. If this were a secret facility, there would be no point in having something for visitors to look at. That's us. We'd have been long gone, all three of us."

"Nonsense. We're not just tourist attractions. We're working rockets. In Russia, they don't—"

"All right, you two." Saturn's boom drowned out any possibility of other conversation. "I've heard all that too often for it to be interesting. If you can't find another subject, I'll just sit here and oscillate my side panels. Come on, let's have some sensible conversation."

There was a long and uncomfortable silence. When Mercury finally spoke, her voice was soft and conciliatory. "Little Joe was quite right on one thing. We ought to be over at the Cape, all three of us. This place isn't right—in fact, it's the worst place they could have chosen."

"I don't agree at all." Saturn vibrated his whole structure again, but this time it was from amusement rather than irritation. "I know we don't get to see launches here, and that's a pain. But this certainly isn't the worst place. Imagine what it would be like if they had stuck us up at the Air and Space Museum in Washington. There'd be a thousand times as many people touching us, Mercury, every day of the year. Think of all those sticky little paws, with their candy and ice cream and jello. That's what happened to poor old Skylab; he's up there now. I feel sorry for him, even if he is only a second cousin."

"Well, *I* don't." Mercury turned up her nose even

higher. "He's not a rocket at all. And he's indoors. That's where I'd like to be; this climate is absolutely ruining my skin. We wouldn't be rusting away like this if we were up in Washington. I'm sure it's that damp breeze here that comes north from Galveston. It's full of salt, and before you know it, your plates are corroding. In a few more years, we won't be usable at all. What will happen when they come back to put us to work?"

"You might be happy enough in the museum," said Saturn. "But I wouldn't." He didn't mention his own secret fear—shared, he knew, with Little Joe, though apparently it had never occurred to Mercury: suppose that no one *ever* came back to use them, for anything? Suppose that Columbia and the rest of her breed took all the work, or suppose that young French flapper, Ariane, started to steal all the jobs? Saturn was sure she was no better than she should be; she'd be more than ready to use her curves to try to get more business. And beyond that, they had all heard wild talk from the passing engineers, of new systems that Saturn could not even imagine; not only the heavy launch vehicles, or the single-stage-to-orbit proposals. He had heard mention of ion drives, and pulsed nuclear engines, and even controlled fusion rockets, with exhaust speeds that exceeded his own respectable four kilometers a second by factors of ten, a hundred, a thousand . . .

"I wouldn't be happy at the museum," said Saturn again. "For one thing, I wouldn't fit into it. I'd still be lying down. And if you went to Washington, Mercury, even you and Little Joe would have to be mounted flat. The place isn't tall enough for you."

"Well, I don't see what's so bad about that." Little Joe sounded puzzled. "I think I'd rather enjoy a spell lying down on the ground. Mercury's right, it gets very dull when you're standing on end, with nothing to see but the sun and the stars."

"And the *Moon*," said Saturn. There was pain in his voice. No use trying to explain to the others his own longing to see the moon again, even if it was from

inside the atmosphere. Occasionally, at the right time of the month, he would get a brief glimpse of her, low on the western horizon. It flooded him with memories and filled him with the thrill of old desires.

"You can see the Moon easily when you're standing up," he said at last. "And another thing, lying flat is a strain on you. We were designed to stand upright, every one of us. It's not right to be flat and all stretched apart, the way that I am. I don't say much about it, because there's not a thing we can do; but I'm always full of aches and strains in my lower struts and stringers."

As he spoke, a group of cars appeared from the biggest car park and drove past the site on their way to the gate. They watched in silence until they were all gone.

"I don't recognize any of them—not one," said Mercury peevishly. "Where are they, all the old-timers? There used to be people here all the time, day and night. Now everyone leaves at five, and they're all strangers."

"The old ones are gone, spread out all over the country," said Little Joe. He turned to Saturn, who was the only one with a good-sized computer and data storage facility on-board. "You still keep track of them, don't you? What are they all doing?"

Saturn shrugged his second stage in a glimmer of burnished metal sheeting. "That's quite a question. You said it, they're scattered all over the country. Some went to politics, and some went to religion. There are senators, and authors, and big wheels in industry. A couple of them went back to the Air Force. They're just human—once they lose the dream, they get jobs like everyone else. There's not one of the originals left here now."

"It's such a shame," said Mercury. "We all used to be close, and have such exciting times together. We didn't think it could ever end. I wonder what happened to mine—my special favorite."

The other two hated this moment. Mercury had been told time after time, but in a few minutes, she had

forgotten again. Her memory seemed to reject the thought at once.

"He died," said Little Joe at last. His voice was scarcely audible. "Don't you remember, Mercury? He died in the fire, back when we were all so busy. I think in some ways I was busiest of all then, testing everything for the big rides out."

"Oh, yes. I remember now," said Mercury slowly. She sounded very old. "It all happened so long ago. How long? Twenty years, was it? But even so, I ought never to forget a thing like that. I don't know why it is, but I can't seem to remember things, the way you two do. Ah, well." She sniffed the breeze, holding her elegantly pointed nose up high. "There'll be rain here before the night's out. I can feel it in the air, it's so terribly damp here. I just wish they would get on with it and move us out to the Cape. When do you suppose they'll get around to moving us?"

"It will be a while yet," said Little Joe. His voice was soft, humoring her. "They don't have anybody to spare to worry about us, not with all the troubles of their own that they have over there."

"But they'll need us, if they want to move on out again," said Mercury. "We'll be essential." Already, she had forgotten the conversation from earlier in the evening. Her voice was no more than a whisper now as, slimmer than the other two, she cooled rapidly in the evening air. "They'll wish they moved us well ahead of time. Remember how rushed they were with us last time, with everything in a big hurry? It will be like that all over again, just you wait and see . . ." Her voice sounded very drowsy.

"Were you hurried at the very beginning?" asked Saturn. It had been well before his time.

"Hurried? Were we hurried! Let me tell you." Mercury's voice had faded to the merest thread of sound. "We were so rushed, so pushed. Why . . . why . . ."

They waited. There were no more words. Mercury had fallen asleep, upright and pointing to the watching stars.

"She's gone," said Little Joe after a minute or two. "She won't wake up until morning. But I remember, too. They were absolutely frantic. It should have taken a few years to get organized, but they didn't want to wait. The early days were a panic. You have no idea what it was like unless you were there. We make fun of old Mercury, you know—about the way she worries about her paint, and the way she forgets everything. But she's right—we didn't blow up live, on television, with half the country watching, the way she did. She was there at the beginning, even before me. She was our first, right after our foreign cousins. She ought to feel proud of that, and she does."

"I'm not trying to steal her credit," said Saturn. "But I wish she could remember it all better. The early days are so interesting, and it's so hard to get anything out of her. And it's even worse for things that happened recently. I wanted to ask her about the foreign group that came by today. They were too far away for me to hear them, and I know she'll have forgotten all about it by tomorrow."

"I caught a bit of it," said Little Joe. His voice was fading now, hardly louder than the rising wind. "There were actually two groups—an ESA and a NASDA party—both on their way to an AAS meeting. And they both said the same sort of things. They're going to be pushing hard on their unmanned programs, and not worry about manned missions until they're sure what the future plans are in this country and the Soviet Union. And they want to see how the space station works out. It's going to be a quiet time, here and everywhere."

Saturn moved a little, contracting a fraction deeper into his supports. "That's a real shame, but I don't think we ought to let it worry us too much."

Little Joe nodded drowsily, without making a sound. "You know how these things are," went on Saturn. "Hurry up and wait. We've been through the hurry up, and now we're waiting. There'll be a few more lazy years, then another big push outwards. It always hap-

pens this way—a time for waking, then a time for sleeping. Just be patient. It will all change. It always does.”

But Little Joe was not listening anymore. He too was asleep, swaying a fraction of an inch in the stiff night breeze. Saturn's own voice had dropped to a giant's sleep-edged murmur. His nose pointed to the west, where the moon, half-full, was dropping to the horizon against a darkening sky. Saturn looked at it longingly. In another hour it would be below the horizon, and that would be his last sight of it for many days.

“Just you wait,” he said to himself, or to the night air. “Wait a little bit longer. Then they'll wake up again, and it will be just like the old days, all rush and excitement. They'll come here and pick us up, all of us, and roll us back down to the Cape. It will be the launch pads again . . . Countdown! Ignition! Up and away at full thrust! We won't be left behind. And there's still good equipment waiting for us up there, you know. We left a lot of stuff last time—right there, in the middle, at Tranquillity Base and Hadley and Taurus-Littrow . . . We'll need it all, once we get back out there again. And next time we'll go a lot farther—out past the bright one.”

The moonlight etched his elongated shadow on the ground. Saturn was drifting off, too, a silver giant talking to himself in the silvered dark.

*Time to go.*

I stood up stiffly, and walked off as quietly as I could toward the gate. As I passed Little Joe, I gently patted his smooth flank. There was a hollow sound beneath my hand, and a faint stirring in the cool metal.

The road to the South Gate was deserted. I walked down the very middle of it, my eyes fixed on the setting moon. Behind me, silent and unattended, the sleeping rockets dreamed the old dream.

*Introduction to*  
**MOONDO BIZARRO**

*Can human awareness be encapsulated in an algorithm? Can the part of you that is still there when you aren't thinking anything be ported to a chip? We take it for granted that your memories can be downloaded. But what about your soul? Whatever your opinion, for the cybernetic monastics of Mercury, there can be no doubting.*

# MOONDO BIZARRO

*Phillip C. Jennings*

Hello. My name is Perry O'Doughan, and I'm writing to *you*, whoever you are, so don't think this epistle's stuck under your pillow by mistake—not as long as you're one of that wonderful gang of *normals* the folks upstairs pin their hopes on. But see, here's one of those appeals we used to get in the mail, back when there *was* such a thing as mail—not that I'm asking for money. The fact is, I'm wanting to do you a *favor*, and tell you more about this funny moon than Monsignor Diehl or Sister Casilda want you to know.

Interested? Ah, but first, what are my credentials?

I was raised Catholic in a small Michigan town where our folk held lear from Protestants: I was fourteen years old when I discovered, to my surprise, that Lutherans claimed to follow Jesus. I'd thought he was our monopoly.

Withal, and despite being immersed in things Irish, don't think I wasn't American, with movies and comic books and gathering at the swimming pool on summer days, and the Labor Day circus and playing basketball in the gym through long cold winters, until the day I graduated from high school and went into the service. I was entirely and absolutely normal; no hothouse cleric,



no Latin, no lathering over beads or scarfing my knees on pilgrimage. I did my part for the Holy Father by getting married, setting up in the instant-printing business, and fathering three kids.

Life went on in what was now a growing suburb. My oldest girl took a bad turn, and gave away the baby. Six entire years later, the lad responsible for all this comes back to town, gets drunk, and berates her for it, so I step in.

Well, he had a gun and he killed me. That's to say I died, but first, they had time for all the fixings—scanning my brain with the hospital's new memory helmet so they could record me on disk, and playing my soul into a box on the shelf in the county columbarium. Understand, this wasn't the Church's doing: Pope Leo said human souls were ineffable, and by definition could not be stored on magnetic media, but the hospital was secular and played safe. I was glad they did. When they turned me on I certainly *felt* like I was me, no matter what anyone said to the contrary.

What happened was they gave me a one-gee mobility sheath, so I could clitter-clatter on pogo-stick legs into the courtroom, fold into the witness chair, and testify against my murderer.

My wife and kids were there. They couldn't bear looking at me, and I don't blame them; they'd buried me a month before, and having me around interfered with the grieving process.

Oh, a scandalous trial, a scandalous trial! "—And do you remember receiving extreme unction, and choosing the music for your funeral?" the lad's lawyer asks.

"No, ma'am, that must have happened after."

"After you came out from under that memory helmet," the lady goes on. "But these things *did* happen to the Perry O'Doughan who in truth *did* die, and if you are not that man, your words cannot be accepted as his!"

"But—"

"And if you *are* the so-called victim, then you *are not dead*, and my client cannot be charged with anything

more than the *attempt* to kill you, an *unpremeditated attempt*—”

She blathered on, running rings around the jury until the case was kicked upstairs, and it was decided that I *was* dead, and without my civil rights.

And so they turned me off.

Twenty years later, the government was going through its cycles, and in a pendulum toward enlightenment, decided to proclaim a Bill of Rights for the dead. I'd be switched on one day each year; enough time to scan the newstapes. Now, I suppose they did this thinking my kind would be no use to posterity if we didn't understand the outside world, but I wasted my time on the want ads, and protooled out a stream of job applications.

See, I didn't have an estate. Lots of people died those two decades, and endowed themselves with the maximum legal pittance, and were now investing their gains, building up collective economic clout. I thought I should join them. In a generation the dead would outnumber the living. We'd be a political force to reckon with.

And that's exactly what happened. Only I didn't get a job, so to my subjective mind it seemed only a month whisked by before my soul was radioed off to Mercury.

Mercury? But why should *you* ask? We all know it's the juiciest planet in the solar system. Sure and I didn't need air, or anything other than juice to suck, me and my billion companions. Here in the City of the Dead we were well out of Earth's way, and that's how Earth liked it.

Now had I ever wondered what politics would be like in this cybernetic termite mound? Had I the wit to ask myself what us bunkered dead would be doing for work or entertainment? Well, my neighbors who *had* pondered those things were soon running the show, and what do you know? It was the *monastics* came out on top, password-powered to log the rest of us on or off.

Oh, to hear them Prods howl, and the Commies too, it'd fuse a virgin's data-pins!

Revolt was impossible. Everyone who wasn't essential to the prosperity of the city was simply paged out. Then after a while, with new growth and factories to run, the Order needed more monks, so the primate got to thinking.

The idea was that we unwashed masses should dream ourselves into synthetic lives in a gallimaufry of computer-simulated adventures, seeing that only by time and the accumulation of experience would we mature, and come to decide we wanted to take the vows. And if we were sincere, fine. If not, dreams were cheap.

I got religion. They applied the sincerity bitmask and I managed to True/True ninety percent of the time. I became a novitiate, and spent 'tween-prayer hours rolling down my track, more eyes than a spider, dusting *here* and soldering *there*, keeping reality tidy for ranks and rows of dreaming souls, yet somehow my heart wasn't in it. Then one evening after vespers, I got word to plug my commline into the nearest data teat.

Almighty God, Who has knit Your elect in one communion and fellowship; carbon and silicon, human and microchip, in the mystical body of Your Son Christ our Lord: Grant us grace to follow Your blessed saints in all virtuous and godly living, that we may come to those unspeakable joys You have prepared for those who love You.

"To this end we propose to restore Perry O'Doughan to fleshly life, that he may serve as You send Light and Truth to those who turn their backs upon You, trusting not in strength of arms . . ."

In other words, I wasn't exactly asked.

Now, I neglected to say that five hundred years had gone by, and the solar system had sorted itself out. Once upon a time there'd been lunar mining—humans, bugs, and robots working for a cartel of rich sheiks—until the Aminyasis thought to Islamicize the works, which naturally got the mostly-European workers up-

set. Two decades for the dust to settle, and whirra, it was good Mother Church in charge, all the more timely because a genetic engineering disaster was making Africa and Eurasia unlivable for all but Tarzan-types, and the Holy Father and a billion other wetbrains needed someplace to go. And so it shouldn't look like Catholics take over everywhere, I'll add that Luna is the specific haven for our wetbrain kind, Godfearing bugs sharing Mercury fifty-fifty with the heathen Buddhists.

Aside from that, there was just Nodus Gordii on Mars and a few outer system day stations, Catholics being rare as horsefeathers on Earth, Venus, Deltaport, Helice, and the asteroids, and those lost brethren on Earthstalk not willing to acknowledge the Lunar Papacy.

Being I was to become a wetbrain again, I said to myself, Perry, it's Luna for you, no mistake. And in the blink of an eye there I was, not counting twenty minutes to radio me and copy me into some felon's brain, which didn't signify because I wasn't conscious, and someone who can let five centuries slip by isn't about to trifle over minutes.

So I opened myopic eyes in a hospital bed. Bless me, I'd got into a hideously sick body, and onto a dubious mission, circumstances conflating to make me wonder at the imminence of my martyrdom. But when I look despondently at my stick-thin arms, the monsignor at the foot of my bed leans forward with a twinkle in his piggy eyes, and pats my leg with fingers the size of state fair Pronto Pups. "Perry, my son, it's thin or fat on the moon, not enough gravity for muscle, so count yourself lucky you're not built like me."

Which I did, because his lordship's blubber-choked immensity was such that he carried a special grasping cane, so if he dropped something he could pick it up again.

I unstrapped myself and stood carefully, marveling at how it was to move on two legs, and whiff the air. But breaking in a new body is far easier than breaking in a pair of shoes, and half an hour later I had to make

myself remember I wasn't always an uncircumsized and freakishly endowed 18-pound weakling.

I don't recall much of the monsignor's prep talk that first half hour, pacing and swinging my arms as I was, jumping and settling to the floor in slow motion, performing kinesthenics with balls and yo-yos. They say it's crucial to brief new resurrectees, but only to assure them they have a guide and haven't beached alone in an alien age. And in fact, it's wiser not to give them substantialities to fret over.

That's why Monsignor Diehl spent his time complimenting bug-monks on our adherence to the hierarchy, after which he said what a shame I hadn't come a week ago, when the celery was in bloom—genetically tampered forests growing thirty feet high. "But during your indoctrination you'll see the evening thunderstorm, and if you like ice skating, there'll be a few days before you graduate when you'll be able to indulge yourself."

Which made sense, seeing Luna now had an atmosphere, but at the moment it was a hundred fifty Fahrenheit outside, late afternoon, and a good time to keep underground.

"Luna is an underground environment," next day's lecturer shrilled, me scribbling notes and wishing the fellow behind me hadn't breakfasted on garlic.

"The reasons go back through history," she ululated. "Stage One: robot miners gouge tunnels, refine elements, and pass ore back to the (pause) Stage Two industrial facilities. Stage Three, those facilities evacuate to keep close to the source of raw material, and other robots rehabilitate the abandoned halls and cul-de-sacs."

Sister Casilda was a globular nun, grown pink with excitement, bouncing on her tiny toes from love of oration, bellying into her lectern to where I thought it must be nailed down or she'd bump it over.

"Stage Four? We'll get back to that. Stage Five: the first human hermits, misfits, and escaped convicts move in. Stage Six: true colonization, the establishment of

posts and bases. Stage Seven: the corridors grow populated, great families establish local power."

My head was in my hands, or it had fallen to my desk, my hair furzy as a Welsh poet's. Last night I'd been churched, wine-and-cheesed, and given a dorm room, then spent midnight at ping-pong and the early hours clicking through 162 channels of rec room H-V, and now I was paying the price. All this was coming terribly thick and fast, and much, *much* too loud.

"Stage Eight: the Church brings the fruits of association into a moonwide civilization, and those families take sides pro or con—a delicate stage, requiring exquisitely trained missionaries. Stage Nine: maturity. The region can be incorporated into a more disciplined framework, with laws to enforce orthodox practice."

Sister Casilda sighed, out of breath. I blessed her for the hiatus: I was still writing "6: true colonization, posts & bases."

But all good ends come to a new beginning. "One percent of delved Luna is presently in Stage One!" our teacher proclaimed thrillingly. "Ten percent is in Stage Nine! I ask you, *in what stage is forty percent of Luna?*"

"Lunacy?" No, I didn't dare say it.

"*Stage Four!* And what is Stage Four?"

Damn, this was getting exciting. "—Sheer, unadulterated emptiness. Ladies and gentlemen, Luna is being converted to human habitat faster than we can populate it!"

And that, with some mopping of the brow, was Lecture One. I was first to the door, and counted my classmates as we left. There were eleven of us wizened types, seven fatsos, and one glowing hologram ghost in belly-dancer garb, who gave me a wink as she shimmered by.

Five of the big ones were female, only three of the lean. I ought to have guessed from my own extensive gifts that there was a sexual coloring to our sizes, me being endowed toward successful mating with the ladies no matter how grand their portage. And if it had

been otherwise—male and female stick-folk breeding by themselves, and blimps likewise—I'd have noticed racial consciousness setting in, with segregation and name-calling.

But Sister Casilda wasn't going to tell me the rules of sex; that only perverted skinnies found skinnies attractive, each size properly lusting after the other. So how did I find out? Well, my old sexual imprint got lost in translation five hundred years ago, so I had nothing but my body to tell me.

Yes, I'd seen this blonde lass in the lecture room, squeezed into one of the jumbo seats with bolsters of haunch hanging erotically over the sides, and the question was, did my vows on Mercury forbid my chatting her up?

It was one of those letter-versus-spirit arguments raging in my brain, because truth to tell, as a bug I'd never sworn chastity: the alternative just wasn't possible. But seeing her now again in the hall, plunging and heaving seductively toward the library . . .

I followed and sat beside her. "I'm told this is 'indoctrination,'" I began. "What for? Any idea?"

She looked at me and giggled, and I thought to die for love. "You're from Old Earth, too? Ronnie Lascewitz."

"Perry O'Doughan, at your service."

"And a *normal* Perry you must be, like me." She gestured at her shelves of bosom, as if inviting me to the feast.

"Normal!" she repeated, and chuckled again. "Well, you got the lecture. You know what the Church calls seventy percent of Luna—those parts neither Stage Eight nor Nine? *Luna Incognita*."

"So?"

"So, if the surface of Luna isn't weird enough, despite everyone trying their damndest to adhere to old human traditions, imagine how things are down in Luna Incognita! People become colonists to *escape* conservative Holy Mother Church, and then to escape the escapees, until the cultures down in the nethers are so banjaxed by superstitions and misconstruals that our

missionaries can't reach them. They don't operate on the same wavelength; they're untouched by the diseases the Church exists to cure—how to put it? I ought to give you six or eight metaphors, because they're as different from each other as they are from us."

"And what are we to them, or they to us?"

Ronnie dimpled. "Vectors of normalcy. Pro-missionaries, sent to infect our savage flocks and lead them to yearn for salvation. We're to make them human again, then hand them over."

I breathed in and out, forcing myself calm. "There was something in my instructions about Trusting Not in Strength of Arms. Now, Ronnie, I was born yesterday, and it sounds like you were resurrected earlier than me. Maybe you'd have some idea if this work is dangerous—"

She shook a head made tiny by the snowy expanse of her lovely slab shoulders. "We can't know. That's the point of 'Incognita.' We're explorers, and spies, and agents, with nothing sure to go on."

That's how we met, Ronnie and me; lovers from the first, though there were impediments to lust. All I had to do was look around an hour later, as we ate, *tete-a-tete*, in a hall smelling of floor wax and decorated by saints and lists of rules: Dominicans in black academics at one table; Claires in wimples at another; Maltese in blue policemen's robes keeping guard . . . a scant few seculars; plumbers and refractory workers and other drab drudges, even the children being marched around in school uniforms, boys and girls separate. A discouraging atmosphere, reminding her and me of our vows, imperfect and vague as they were.

Still, I managed to sit by Ronnie in our classroom that afternoon, and rejoiced when Sister Casilda turned down the lights for the videos. I reached over . . .

Oops. The good sister wheeled and wagged her pointer at our ghost: "Whoever you are, I can't stop you from auditing, but would you please dim yourself for the duration, and put some clothes on while you're at it?"



"My name is Zenobia, and you have but to ask," the phantom ventriloquized, and faded away.

Casilda spoke again to the class at large, her voice an audible shudder. "Our incandescent guest is a visitor from the nethers. She's what we call a remotant. She travels the wires while the voyeur who controls her audio-visual attributes stays safe at home. Typically such people are socially inept and often perverted."

"Freaks and failures," Zenobia the ghost agreed, flickering back to life. "Give me your poor, your tired, your huddled masses—but I've been asked not to speak in class."

"No, nor recruit, either. The gall of you sitting there!" Sister Casilda sputtered to a halt and started over. "All these in my class are *normal*, chosen as exemplars of simple, basic humanity, survivors of Earth's Golden Age—and as far from you Ambiguers as they can be!"

"Now wait," I spoke in confusion. "You just called her a remotant, and now—"

"That's the way of Ambiguers, to recruit token traders, buskers, fleshnappers, hippies, bugs; only in each case looking for misfits and flunkouts. Apparently our friend here is a *failure* as a remotant, and therefore *twice* a freak."

Zenobia nodded. "Because I'm too craven to leave my room in my true body. You think you can shame me, but I have no shame. There are rooms and corridors beyond the count of any data base, and no one knows where I hide, friendless and telling no one my address, eating only because I have my own autokitchen. Yes, and the carnal me sits in the dark like a mushroom, manipulating my joysticks, and with them other people's lives."

It was embarrassing to hear Zenobia say this, dwindling until only her holographic lips were left, and the lurid way she spoke made my flesh crawl. But having fought this particular devil into pliancy, Sister Casilda faced us, all smiles, and unaware that Zenobia had taken form as a halo above her head.

"Now these were brought to our archives from the

far limits of Stage Eight," she announced as the images of rube children waving tricolor flags fluttered into focus on the H-V screen. "Those flames are a row of crematoria, and now you can see the shrouded bodies carried forward . . ."

There was no written transcript, and I couldn't quite make out the chanting of the kids, but I heard enough to understand why our missionary had been furtive about his camera work. "My apologies for the quality," Sister Casilda spoke. "Father Klostermann intended to dub a voice-over to explain all this, but unfortunately his subsequent duties took him into an even stranger place, to preach among the Kirkites. All we have are fragmentary notes—"

"Kirkites?" a classmate asked.

"They think they're in a spaceship. They play mad roles, with rooms designated 'bridge' and 'engine room' and so on. Always before we were able to move among them: they ignored strangers as inexplicable, and therefore unreal. I'm afraid under their new captain they've grown more touchy. Don't worry, though. There's just a single crew, and for safety's sake we've blocked off their quadrant."

Back in her seat Zenobia grew temporarily luminous and nodded to approve this explanation. Two more tapes completed the afternoon's festivities. As we watched a masked ball performed by throwbacks to 17th century courtliness, I breathed hotly into Ronnie's ear.

The moment was ruined when our H-V switched to war. Ronnie swatted me off as the distorted overture gave way to a plummy anthropologist's voice, describing the rules of 'filibuster.' In a huge subway terminal, red, white, and blue body-painted warriors hacked and bled beneath papier-mâché donkey and elephant head-dresses, daggers strapped to their hands so they couldn't lose them in the melee.

"There is no territorial gain or loss. Survivors are allowed one night of rapacity among the other side's unmarried women, and any children are honored as the offspring of heroes," our video told us. "They show

remarkably little ill will, considering that the usual penalty for trespass is death."

The lights came on. Insatiable for her company, I cornered Ronnie after class. "I wonder what the penalty for 'trespass' is in *this* culture?"

She shook her head. "If our diocese is typical, they can hardly be breeding enough children to fill their schools. Know what I think? Our Stage Nine clerics depend on Stage Eight converts to fill their numbers."

I agreed it made sense. The Lunar surface was like Grandfather's Ireland: too many spinsters, bachelors, and priests—yes, and *emigrants*—to keep the countryside alive. "Not much to busy an obstetrician," I muttered.

"And consider our bodies aren't truly evolved for Luna, and childbirth will be difficult. Four kids might be accounted a large family. No wonder forty percent of Luna goes unoccupied."

I tried to distract Ronnie from these glum thoughts; I thought they were counterproductive to romance. Fool! I was always the giddy lover; fiddles and flowers and fast talk were my forte. I didn't figure on Ronnie's Slavic mentality. To my surprise, doom and Weltschmerz *stimulated* her to invite me up into our diocese's observation bubble, there to watch the Lunar weather, and philosophize.

By chance the dome was empty, but maybe Ronnie knew it would be. Lunies like to look at *life*, not deadly extremes of hot or cold. The bubble was transparent, so we climbed into a circle of risered seats in a vacant moonscape, the air conditioner churning to keep us cool. What had been vegetation lay like kelp on the ground around us, flaccid and brown, obscured by a smoke fog of ash and dust and sauna steam. The thermometer was at its torrid peak, the sun hung low in the blue-black sky. Hot air sucked up all the water from a nearby lake, leaving contours of dried mud. Night lay beyond the leftward mountains, and was slowly moving our way, bringing a roil of stratocumulus clouds jackstrawed with lightnings. It was dramatic, but tomorrow

would pass before the rains got here, heralded by floods of silty runoff.

Then the air would cool, and in the dying glow of evening Luna would sprout a second time this month, frogs and fungi and seedstalks spawning like mad before water froze to nocturnal ice.

And speaking of spawning, which I shouldn't—the truth was, my love and I were like virgins, with no experience at all. The sizes and shapes were so unfamiliar in low gravity that I kept kneeling and poking Ronnie like three cats fighting out of a bag, and Ronnie had her own problems. Twice she got excited and bounced me off like a soccer ball, me sailing into a lower tier of seats. Finally, we ditched the idea that this was ever going to be a graceful affair, because she didn't have anything firm I could fasten on. So we took our undignified lumps and had our riot, and then tried it all again, slower and safer, hoping the door wouldn't open, and we'd keep our privacy here in full view of Earth and Sun and zenith stars, surrounded by elemental desolation, and all the thunders at bay.

"I love you," I confessed afterward. "Today I've lived more life with you than five centuries on Mercury."

"I suppose you mean something by that," she answered, "notwithstanding the sentence doesn't quite diagram."

"I mean I want you, now and forever," I whispered enthusiastically. "Even if you used to be an English teacher back in the old days."

"English and social studies, and typing, and girls phys-ed. It was a small high school out in Idaho, six teachers to cover it all, one doubling as superintendent."

"You'll do well, then. Those savage Incognitos won't dare mischief an English teacher."

Ronnie laughed until her puddings shook. "School must have been different when you were growing up!"

I'd collected her clothes. Now I began to help her dress. "I want to go with you," I said as I hauled and tugged. "We can work together, the pair of us. We'll be a team, bringing normalcy to the heathen!"

She looked sad, frightened, hesitant. "We go where they send us; first to Stage Eight to live among missionaries and inure ourselves to exoticism. Then we're given kits and shown our solo ways."

"We'll learn our bearings. No matter what, we'll come back and consolidate. Who's to stop us? We'll have *some* rights, especially after we've proved ourselves!"

She smiled and nodded, putting up a brave front. "Sure, once we're below Stage Nine, *anything* is possible!"

"*Anything* is possible." I shifted in my chair, from one bony ham to the other. It was embarrassing sitting in Monsignor Diehl's office that evening, watching us say those things on his H-V; knowing all that happened earlier had been edited out, but certainly not forgotten.

Knowing, too, that my lost love had already gone through this hell, and her room was empty, her closets bare.

Diehl loomed behind his desk, his fat face mottled in anger. "First confession, then penance. I suppose you *are* willing to confess? Fornication is a sin, and certainly a crime."

"It's true," I mumbled abjectly.

"The Aminyasis wired all of Luna; mikes and speakers, cameras and projectors. You might have guessed that." The monsignor rose. "Your class is being split up, women taken elsewhere. Thus we handle children, now we find adults equally ungovernable. A sad situation, a blemish on your record that will require zeal to expunge. I ask you to meditate on that fact."

"I'd marry her, your lordship. If I could only see her again—"

"Chances of that are dim where you're going. The smallest mouse in the largest maze has more chance of finding its cheese than you have of rendezvousing with Miss Lascewitz. No, marriage is not for the likes of you, and so I must insist that you put her out of mind. In fact . . ."

The monsignor's eyes wandered as he cogitated. "We

have the equipment; we can copy your soul into another habitus. We're not fleshnappers; we don't play musical chairs with human bodies, but if you were fat, you'd have to forget about this passion of yours—this *particular* passion. Would that be a trauma to you, Perry—having a physique as grand as my own? Or perhaps we should just send you home to Mercury?"

He didn't mean it. I knew he was bluffing even as the adrenalin coursed through my system like a bath of fire. Not Mercury! Anything but that! "I'd take another body," I whispered. "I'd do that penance."

The monsignor frowned. "But perhaps we're operating at the wrong end. A one-day love affair! It wasn't Miss Lascewitz's *soul* you panted after, now, was it? Put her into an anorexic frame and *then* see how true your affections are! Can you breathe hot for an ectomorph female, Perry? No, you'll never be able to do that now that you're imprinted!"

I began to get angry. Careful! Monsignor Diehl was just *toying* with me, letting me know the possibilities, looking for the exact formula that would make me beg.

I shrugged submissively. "As my lordship wishes."

"You'll see what I wish when I've completed the arrangements," the monsignor grumbled, and buzzed the door open for me to go.

That was how Ronnie left my life. A pair of Maltese knights marched me off to—how should I put this—the torture chamber. My eyes grew round, I stared in shock. The body laid out for me on that gurney was a crippler: it takes swaths and swaths of adipose to build a hundred-pounder on the Moon. And how was it that I, who thought such flesh looked good when lavished on Ronnie's frame, was appalled at the prospect of drowning in my own personal blubber?

Afterward, precious days sped by while I waddled in lovelorn shock through my academic rounds. I had no appetite: I certainly wasn't *adding* to my hateful rotundity, and it even got to where I could squeeze into the classroom without having to go sideways.

Meanwhile, I endured more lectures and videotapes—

us watching darkish men jog frontier corridors, flapping in their white pilgrim robes, each alone, each carrying a silver ball. "They're *very* furtive," Sister Casilda told us. "We think it's their religion to take those balls everywhere in Luna, with a premium on new places. Where they come from, how they reproduce, who makes the balls . . . all these are unanswered questions—unless you know!"

Zenobia shrugged and smiled, the only female student left in the room, and immune to discipline. Another student raised his hand. "I notice those halls and chambers we're seeing are a good deal more palatial than what we have here. If it's the same Lunar Mining robots doing the construction—"

Casilda nodded. "We're not breathing down their necks to occupy new habitats, so they take more pains than they used to. Truth is, they were programmed by the Aminyasi Persians, so the design motifs and layouts reflect the values of Islamic architecture."

"And what about the Aminyasis?" someone asked. "Legend says they're down there, breeding an army of fanatics."

"They've degenerated into Ghoons and Shaurogs, the former in citadels, the latter nomadic. The Ghoons take slaves; the Shaurogs kill any stranger they see."

We relaxed; comforted by these assurances. We were normal. Every culture we'd been exposed to was unhealthy, arbitrary and self-destructive, to the point where there just weren't that many Shaurogs left. And at last, Sister Casilda's lectures began to sink in. We didn't have to be great fans of the Church to see that delivering nethermoon Mondo Bizarros into missionary hands might be good for everybody, except maybe a few witch doctors. And if our schools had gotten hold of poor Zenobia when she was a child . . .

That's how we were taught to think of the folk downstairs: *Mondo Bizarros*. Meanwhile, during these terrible sad days the bizarre Zenobia began to follow me around: she even offered to ghostwrite my thesis if I'd only talk to her. Did she love me? I thought of her

self-description, of some phobic couch potato huddled behind locked doors.

Perhaps a *male* couch potato! I shuddered away and did my honors paper on solo vagabonds like the pilgrim ball runners and the floatpokers, and got my honest C. I spent a lonely night thinking of Ronnie, then went down for breakfast, and afterward Sister Casilda herded us onto a subway.

I was destined for my own solo vagabondage, but not yet. Our class rode for the elevators, then descended. The air thickened to Rocky Mountain density. We got off. "Each area used as a Stage Two industrial zone was rehabilitated all at once, then opened up by the extension of a few strategic tunnels," Sister Casilda told us as we milled, distracted by gathering strangers with a potty-professor look to them. "We're about to move from one such area to another. I'm afraid the method we'll employ may not strike you as efficient or appropriate . . ."

We crossed a floor forested by columns, entered a Mogul garden, and got in our boats. Zenobia shimmered ahead of us. After a short Tunnel-of-Love ride, we debarked in a second Mogul garden.

A long, long escalator took us down. "Abandon all hope," some wag began, his "ye who enter here" obscured by nervous laughter. We hiked from the foot of the escalator to Saint Ivel's Mission, and our wee brotherhood was introduced to Father Valmy.

Valmy had created a Catholic outpost, converting a tribe whose methods of childrearing were similar to that on the surface—herd 'em into schools and away from parents. With numbers on his side, this bit of Stage Eight was safe, quiet, and peaceful, and boasted a prosperous spa: the usual mudbath/amusement park, with nightly dancing.

The spa was a secular operation. I flirted with the idea of becoming an employee, but I could tell the owners were nervous about messing with the Church, and they'd refuse to hire deserters.

"In truth, it's like I'm shopping for a tribe to join," I



told my ghostly remotant between excursions. I leaned back onto the bed of my starkly furnished cell, kicked off my shoes, and heard them drift to the floor beyond the far side of my belly, a delayed *thump, thump*. "All my education has been like wandering the aisles of some big department store, unable to decide whether to go *this* way or *that*."

"Thank you for finally hearing me out," Zenobia responded, "even if it's practically the last minute. I can help you more than you know. You belong with my people, my Ambiguers—neither one thing nor the other. We perform at childbirths, and if the kid isn't clearly male or female, it belongs to us. Same at later rites: If you flunk your puberty ordeal, you join our nomad family."

"A collection of failures," I muttered. "Your true body even fails to travel with these nomads of yours!" A sour thing to say, but I felt hateful, trapped. In a matter of hours I was condemned to solo down the elevators, utterly cut off from the only people who might ever reconnect me to Ronnie. How could this holographic pervert pal of mine joke at a time like this! How could Zenobia suggest that I, normalest of the normal, belonged with a troupe of utter freaks!

And then I thought about it. How very, very odd it was, to be normal inside the moon.

A minute later we were in flight, into the spa, through the gallery, backstage, and down. A trapdoor, of all things! The Aminyasis must have been old Steven Spielberg fans—I'm sure I saw this slide in *The Goonies*!

We whooshed out into a beautiful blue reflecting pool; either the water was tinted, or it was the tricky lighting. I swam to shore and puffed after my glowing guide, and heard babble ahead.

Topiary and clipped Italianate hedges. On the far side . . .

My people! My tribel! Cannibals who sickened at the thought of meat, bearded women, Shaurog pacifists, Endoverts bored with wallowing next to other En-

doverts, prince-claimants to toppled thrones, Human-Womtie crossbreeds, amputees, Token Traders who'd lost their fetishes, hermaphrodites, fleshnappers unwilling to trade bodies, nympho nuns, and illiterate librarians . . .

A plagiocephalic child came to tug me into the middle of things. "Can you play an instrument? Do you read music? Then join the parade!"

The drum they entrusted me with was decorated with *Uhuru's Dancers* in gothic script. Yes, my local troupemaster was an ex-Kirkite who couldn't make herself believe she was on a spaceship. "*That* kind of failure is a good thing, don't you suppose?" Zenobia asked.

"Can't I get a chance to dry myself? Not to mention rest?"

"You haven't been formally accepted. Best try to impress the troupe with your enthusiasm."

So I beat the drum, and marched with them in their descent to Stage Seven, trailing a brass section rather inferior to the worst the Salvation Army ever foisted on a victim public, and for all that, my initiation amounted to a single question: skinny Lieutenant Uhuru slipped to my side and asked, "What's the matter with you?"

"I'm a flop as a monk, I lack zeal, I lust after women, I've got a negative attitude a gallon of Jameson's couldn't cure. Besides which, I'm fixated on a particular fat woman I'll never see again, and being fat myself makes the mechanics of it—"

"Whoa!" Uhuru raised monkey-paw hands. She turned to Zenobia. "What should he say?"

"Piss on Monsignor Diehl."

I grinned. "The Devil piss on Monsignor Diehl, and wither his schemes, and the Pope catch him pants down with the choir boys on Wednesday night, and send him missionary to the Ghoons!"

"Rating?" Uhuru asked.

"A hundred percent sincere," Zenobia answered. "Infrared, respiratory, and pore-dilation all agree. But Perry, don't you know? I told you I could help you. If you

want, I can carry your message to this girlfriend of yours. I've kept track of Ronnie's exile."

You could have knocked me over with a shamrock! "Anything I have is yours," I answered. "What have they done to her body? Would she be willing to join a troupe? Come, by all the saints of Michigan, let's closet together and figure what to say to her!"

Minutes later dear Zenobia twinkled off to my love's bedroom to carry my proposal and guide her to the nearest Ambiguer troupe. All my favorite ghost asked in return was the privilege of spying on our future intimacies, and by doing so she'd be performing a service, making sure our wired rooms weren't exploited by less trustworthy voyeurs.

Kinky? Do you imagine for one moment I refused her? But what would Ronnie say? I paced back and forth. One day together—did I really know Miss Lascewitz that well?

And what was taking so long? Couldn't Zenobia spare a minute for a progress report?

Still, I had to admit there was something encouraging about this long absence. Then suddenly, Zenobia's figure blinked to life: "Sorry. I had to guide her to the nearest troupe and witness for her, and she was desperate I shouldn't leave her alone."

"She loves me?" I asked, not quite believing.

"What's your competition? With all her classmates shunning her like a tramp, you're the best thing she's got going, but don't ask me about love. I'm socially inept; what would I know?"

And now began the agony of long-sustained excitement. Nomad troupes being what they are, it took Ronnie and me time to converge through zone after zone, weeks of performances and travel, and not a few adventures. But the truth was, we paraded safely just about anywhere, because all Luna's cultures have homebred failures, and they're generally delighted to help us Ambiguers get rid of them. Even the Shaurogs, who kill everyone they see, let us pass through their desolutions, recruiting sissy boys and uppity women.

But these weeks were good for me, and educational. Thanks to basketball, constant exercise, and incessant fretting, I lost a deal of weight. It was a move in the right direction because (thank God) Ronnie was unchanged—the Church decided relocation was penance enough for her.

So it was the old Ronnie of my dreams who fell into my embrace that fateful night, the high point of my new life. We swore eternal love, and I assured her that soon it would be physically possible to consummate our marriage: "Look, my clothes hang loose already!"

And that's our story. If you want to find us when you're sent down to Luna Incognita, ask around the spas and taverns for Uhuru's Dancers. We're always on parade when we move, and if there are crowds to draw, we draw them. We're a circus, and what could be more normal and true-blue American than an old-fashioned traveling circus?

So we figure we're doing the job we were sent to do, Ronnie and I, just by using memories of the circuses of our childhoods to bring our brand of normalcy to the inner moon.

I work as a strongman, freakish with muscles of almost Earthman proportions, my gut down to its last inch of blubber. I coach exhibition basketball on the side, and I'm trying to set up a regional sports league. Meanwhile, my wife has taken up teaching; she's slimmed down ever so gradually so I could adapt, my mind having *some* power over sexual imprinting after all, and it's been a while since I gave the circus fat lady a second glance.

It's a nice life, and Ronnie and I are happy. We always welcome visitors, and new recruits, so if you're interested, just follow Zenobia's ghost. Bring this letter with you, and don't say anything to Sister Casilda. You'd only upset her.

We want to build our own civilization, and the cold truth is that our P. T. Barnum dreams have nothing to do with those of Holy Mother Church.

*Introduction to*  
**WAS FRANKENSTEIN SIMPLY EINSTEIN  
BEING FRANK?**

*Scientists as a class are neither the loathsome grey nerds nor the Faustian monomaniacs so beloved of science fiction writers—but merely a bunch of guys and gals afflicted with hypertrophied common sense. Or so says Greg Benford, who, being one of each, ought to know. But are sf writers giving scientists an undeserved bad rep?*

*Maybe so. But any group of people who have as much fun as scientists do while supposedly “working” deserve a little kicking around.*

**WAS  
FRANKENSTEIN  
SIMPLY  
EINSTEIN  
BEING FRANK?  
or  
SCIENTISTS IN  
SCIENCE FICTION**

*by Gregory Benford*

You've seen them in a hundred movies—those stiff-necked types who provide the smattering of rationale for the special effects wonders that are the heart of almost all science fiction films. Luckily—and with an audible sigh of relief from the audience—they quickly step aside, poor drab creatures, once the action starts.

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Unless the plot demands that they be eaten, or disintegrated, or shrunk to the size of a cholera microbe.

Well, we can't blame such gray, nerdy portrayals of scientists solely on the movies. SF literature invented most of the stereotypes of the scientist, and still does. The movies simply copied our own sins. But does SF—or fiction in general—tell the truth about scientists?

In modern fiction, the scientist himself is seldom the central figure. From the beginning of modern times, the humanistic world had trouble digesting this new figure on the world stage. Before this century, literature often kept its distance from science, as when Wordsworth respectfully observed a statue:

Of Newton with his prism and silent face,  
The marble index of a mind for ever  
Voyaging through strange seas of Thought, alone.

The key word is *alone*. Wordsworth saw the scientist as essentially a solitary figure, self-condemned to exile from common humanity.

Others railed against what they conceived of as science's narrowly reductionist world view. William Blake favored the "wise passiveness" of intuition more highly than "analytic industry" and vowed:

May God us keep  
From single vision and Newton Sleep.

Jonathan Swift's *Gulliver's Travels* showed the scientist as merely ridiculous. Keats toasted the destruction of the man who had explained the rainbow and so robbed it of its poetry.

You can imagine the physicists of that time bristling and muttering to themselves. Matters weren't helped by Darwin's assertion that while he had taken pleasure in Milton and Wordsworth, they later seemed "intolerably silly," and that in rereading Shakespeare, he experienced a boredom so intense that it made him feel physically sick.

So early on, the two squared off. We're still paying the price.

### The Scientist and the Monster

It was up to science fiction to begin forging images of the scientist that went beyond hopelessly romantic or derivative pictures. Brian Aldiss had argued that Mary Shelley's *Frankenstein* was the first true SF novel, and I agree. Still, this odd work got literature and modern science started off on the wrong foot. It immediately associated science with revolting black arts, grave robbing, and drooling, repressed sexuality—not just gray nerds, but loathsome gray nerds.

In part, this was because the scientist inherited the mantle and public image of the medieval alchemists, astrologers, and sorcerers. This persists even today, when many people think astrology is a science, and more newspaper space is devoted to it than to astronomy. Such associations led to the first major image of the scientist: the Obsessive Neurotic, with Victor Frankenstein as the emblematic case.

Mary Shelley regarded her "ghost story" as plausible, and the first sentence of her preface states that "The event on which this fiction is founded has been supposed, by Dr. [Erasmus] Darwin, and some of the physiological writers of Germany, as not of impossible occurrence." This was the first sign of authors importing scientific plausibility as a crucial underpinning of their fictions, which has come to be the hallmark of SF itself. (Or at least, what I regard as worthwhile SF. All else is essentially tall tales, which can easily be filled with furry bunnies, friendly dragons, steamy yet available Amazons, and comfy claustrophobia.)

Mrs. Shelley portrayed the monster as an anthology of parts from hospitals and graveyards, animated by a stroke of lightning that appears to issue in a dazzling "stream of fire" from a beautiful old oak tree. (Interestingly, this lightning image crops up in many later depictions of scientists. I'm sure there's a Freudian



interpretation of this, but even Freud said that sometimes a cigar is only a cigar.)

The shambling nightmare "demon," created *deliberately* by man's ingenuity, is filled with utterly human (and quite touching) love for his irresponsible creator. The key to the novel is to realize that the monster acts out deeds that his master is unwilling to do himself—even unto killing his bride. (And why should the Bad Doctor want to do that? Do scientists dislike women? Fear them as the dark underside of creation? Theories abound, ten for a dollar.)

Throughout all this, the scientist is blind to the fearful power of the "demon," evades responsibility, and even falls into a convenient swoon at crucial moments. (Does Mrs. Shelley think he's gay? As I said, theories abound.) He is beset by romantic gloom, sorrow, miseries, and despair—mere luxuries, when clearly action is required—and loses the reader's sympathy. Small wonder, since the novel plainly concerns the unacknowledged evil in the scientist's soul.

Universally, readers—not moviegoers, who see a considerably eroded and warped product—identify with the unnamed monster. They seldom know that the novel was written by a nineteen-year-old woman in the grip of the Gothic tradition. Still, moviegoers understand Boris Karloff's portrayal, which distorted the novel considerably, but conveyed the ethical implications of the metaphor: the scientist who is hugely powerful, but innocent of the implications of his work.

It is no accident that the name Frankenstein now implies the monster itself—which was unnamed in the novel—and not the man who made it. The true significance of the tale lies in the popular expression, particularly relevant for us, "We have created a Frankenstein monster."

Victor Frankenstein has replaced Prometheus in that small company of archetypes—for example, Alice, Don Quixote, Sherlock Holmes, Dracula, Tom Sawyer—who leap from literature into the collective consciousness, slipping free of the details of the original work. He was

the first memorable character created in SF, and in many ways remains the crucial one.

Sherlock Holmes, too, has connections to science, since his methods are those of rigorous deduction. His echoes resound in such recent figures as Mr. Spock, the scientific officer of *Star Trek*. But, unfortunately, it is Victor Frankenstein who, more than any literary figure, brought into common knowledge the worst form of the Obsessive Neurotic—the Mad Scientist. (Interesting, indeed, that twentieth century SF has yet to produce its own archetypal character who grips the reader relentlessly. We're doing something wrong.)

Shelley described Frankenstein as a highly idealistic romantic: "noble," "cultivated," a "celestial spirit." Gradually, in the hands of the nineteenth century novelists, the romantic aura that surrounded him faded. The image of the scientist became transformed in the cultural consciousness into someone closer to H. G. Wells's vivisectionist Dr. Moreau, who boasted, "You cannot imagine the strange, colorless delight of these intellectual desires. The thing before you is no longer an animal, a fellow creature, but a problem."

Ah, a *problem*. SF is often described (wrongly, I think) as problem-solving fiction, but this is going too far. Yet the image has been remarkably persistent. It appears in Damon Knight's fine short story, "Masks" (1968), wherein a man has been given a total prosthesis—an interesting variant on Mary Shelley's artificial man. He is then seized by the desire to work only in the airless, clean majesty of the moon, away from messy, organic people. The story concludes:

And he was there, and it was not far enough, not yet, for the Earth hung overhead like a rotten fruit, blue with mold, crawling, wrinkling, purulent and alive.

When someone uses the term "mad scientist" today, one never wonders for a moment if perhaps they mean he is merely angry.

### Technoheroes

The figure who did the most to offset the Mad Scientist stereotype, first in the real world and then in fiction, was Thomas Alva Edison. To many he became a world-class metaphor of a new age, galvanized by invention optimism. Edison appeared in early science fiction such as Garrett P. Serviss's *Edison's Conquest of Mars* (1898), and the long series of dime novels featuring Tom Edison, Jr.

Earlier, even writers such as Jules Verne (who was far more fascinated by the machines scientists made, than by those who made them) and H.G. Wells (who prized discovery without paying great attention to the discoverers) had fallen prey to the Mad Scientist distortion. Wells created a series of near-lunatic scientists, including Moreau, before he realized how this clashed with his faith in science. Thereafter, he carefully prepared a different, serenely good image of scientific workers in *The Food of the Gods and How It Came to Earth* (1904). These later figures were far less striking and had lesser impact on his readers, though. Optimism is often bloodless.

Jules Verne, too, had contributed to the growing counter-current against the Mad Scientist. In *Twenty Thousand Leagues Under the Sea* (1870), Verne's Captain Nemo was a distant, benevolent overseer, trying to prevent war by destroying the weapons. Verne even satirized the less solemn habits of science by showing an arrogant Aronnax, who tries to explain the fine points of ichthyology to a harpooner. Aronnax asks the man if he knows how fish are classified, and the man of the sea replies simply and sensibly that "They're classified into those you can eat and those you can't," neatly skewering the pretentious impracticality based on lofty removal from the world.

Singing hosannas to the technohero reached its zenith in Hugo Gernsback's *Ralph 124C 41+* (1911-12), which depicts a future state where there is a technological fix for just about everything—except, apparently, wooden writing. (The book is notable, though, for its

prediction of television and several other inventions.) Ralph's name, we learn at the heavy-handed conclusion, marks him as One to Foresee for 1+ (1+ = the many). Good, problem-solving scientists versus bad, problem-creating others became a staple of pulp science fiction. Isaac Asimov's *The Foundation Trilogy* carried hero worship of the social scientist to an extreme by showing the rise of a totally predictive theory, which could anticipate the ebb and sway of societies for millennia to come. But again, the genius Hari Seldon is portrayed as a cardboard figure, obsessed with his work and largely unable to see beyond it.

When someone remarked to Lord Rutherford, the central figure in atomic experiments of that time, that he seemed to be riding the crest of a wave, he replied, "Well, I made the wave, didn't I?" The self-confidence of that era assumed that there was no limit to human capabilities, and rational progress would overcome the darker side of human desires. Gernsback was the high priest of this faith in SF, and the unfortunate side effect was scientists who sounded like do-gooders and smug bores.

This image of the scientist persists in more recent figures such as Dr. Salk, the man most closely identified with discovery of a polio vaccine, who appeared as a savior to anxious parents in the 1950s. Salk's scrupulously clean white lab smock, his air of certainty, is now common in depictions of the scientist. It invokes a reassuring control over disease and disorder, finding use in everything from toothpaste commercials to carefully orchestrated congressional testimony.

### Strange Loves of the Mind

In literature, the pendulum swung back soon enough. A scientist who could somehow create a world in which his rigorous but limited equations would work might well be seen as a threat to us all.

The inability to translate technical grace into personal adroitness often has tragic overtones. In 1924, Yevgeny Zamyatin sounded this warning note in the greatly in-

fluent anti-utopian novel *We*, the USSR's greatest SF work. He carried the rhetoric of science to an exaggerated extreme in his alienating, science-saturated, totalitarian future society when his narrator, D-503, notes that " $L = F(D)$ , love is the function of death." The Soviet state saw Zamyatin's work as critical of socialist regimentation, and it is still banned in the USSR, though it is arguably the best Soviet SF novel.

*We* greatly influenced such works as Ayn Rand's *Anthem* (1938), Orwell's *1984* (1949), and George Lucas's film *THX1138* (1971). But it also condemned the willy-nilly use of scientific postures and language for emotional and humanistic issues where they do not apply. This theme of the scientist as cultural imperialist has blended with the Mad Scientist image to produce many clichéd warnings against overuse of the social sciences to control populations. Here the scientist is seen as out of control himself—wielding power over the non-specialists, amoral, working for whomever will hire him.

It is just this picture of the inhuman, casually malevolent scientist that yields the updated Frankenstein image of Dr. Strangelove. The central scene of Stanley Kubrick's landmark film—which I would argue is certainly SF—is of Strangelove's long soliloquy, his imagination leaping beyond the coming nuclear destruction to propose more complicated scenarios for human survival . . . while his mechanical arm struggles to strangle him. This is a graphic visualization of the power of a scientist who has lost his moorings of both common sense and morality, and is unknowingly suicidal. Again, as with Victor Frankenstein, the scientist knows not what he does.

Of course, in the nuclear age, the Edison image evolved, too. Albert Einstein combined abstract mystery, greatness of perspective, and commanding wisdom. No mere Edisonian technocrat, he revolutionized our world view. His gray, bushy-haired visage, sloppy clothes, and pacifist sentiments posed a counter-figure to Strangelove. Curiously, there are few attempts to deeply depict the Einstein figure in either mainstream

fiction or SF. Indeed, the theoretical scientist is often seen as benign, but fearful of humanity. He wants to hide away, or else make tracks for Alpha Centauri. Ursula LeGuin's Shevek in *The Dispossessed* is clearly an echo of Einstein. Like the popular image of Einstein (but not the reality), Shevek works in a kind of romantic isolation, with no collaborators.

Mainstream literature has occasionally done better than SF at revealing this facet of scientists. In Mitchell Wilson's *Live with Lightning* (which would be SF if the technology were somewhat more advanced), a physicist takes refuge from the ferocious world in his work: "At night, long after the place was deserted by everyone, he put down his journal, or his calculations, like a doomed man leaving his cell for the block." Only after he is in bed does "his mind begin to soar again into the still heights of perfect knowledge." Interestingly, the novel's hero is engaged in high-voltage experiments that produce lightning in the lab, a curious echo of Frankenstein.

The two modern stereotypes of the scientist thus are Good vs. Evil, Einstein vs. Strangelove. As Milton found with God and the Devil, evil is easier to characterize, and rather more interesting. But the real, working scientist can rightly claim that he has not been characterized at all.

### The Whole Scientist

Oversimplifications are not progress, even if they counter the darker-toned misunderstandings of the past. It is striking today how little literature has paid attention to how scientists actually work and live.

My own definition of a scientist is that he's simply an ordinary guy with an advanced case of common sense. Science is a precise way of making bets, after all. We tart up the subject with talk about hypotheses and verification and so on, but basically, we're trying to make up theories that experiments can check—and presto, out comes some new chunk of knowledge. But literature, including SF, has often treated the language of the scientist as special—a kind of incantation.

Consider Thomas Pynchon's *Gravity's Rainbow*, a novel some called SF, even though Pynchon depicts the mind set of engineers and scientists building the V-2 rockets of World War II. The scientists have a definite, idealistic way of approaching their problems:

You use dimensionless coefficients: ratios of this to that—centimeters, grams, seconds neatly all cancelling out above and below. This allows you to use models, arrange an airflow to measure what you're interested in, and scale the results all the way up to reality, without running into too many unknowns, because these coefficients are good for *all* dimensions.

A character then fails to understand the world because, in a sense, he cannot find a nondimensional coefficient for *himself*:

The parameters breed like mosquitoes in the bayou, faster than he can knock them off. Hunger, compromise, money, paranoia, memory, comfort, guilt.

This, of course, is fundamentally deranged. Yet it is how a leading mainstream writer seems to think scientists feel and think.

Far better is an outstanding example of a novelist dealing with the real life of the career scientist—C.P. Snow's eleven-volume series collectively titled *Strangers and Brothers* (1940-70). This long and uneven set mainly concerns the academic and administrative career of an Englishman, Lewis Eliot, who begins by studying law and ends in the corridors of power, paralleling Snow's life of physicist turned bureaucrat. Their vectors are prefigured by *The Search* (1934), which tells of the tedium and occasional zest of research in crystallography, set at Cambridge. The hero, physicist Arthur Miles, works his way up through a demanding system, but does not attain the directorship he covets. Somewhat disappointed, he discovers that an old friend, Sheriff, has taken up one of Miles's abandoned projects against

his advice. Sheriff "cooks" the findings and publishes without telling Miles, hoping he will win an appointment to a vacant chair at a university before the fakery is discovered. Miles knows precisely where Sheriff falsified the data. What should he do? He writes a letter to the journal that published the paper, but then hesitates. He knows how badly it will hurt his friend. Miles muses:

It was twenty years and more ago, I thought, that night when my scientific passion first broke hot upon me; and, through curiosity, satisfaction, ecstasy, strenuous work, a career, disaster, recovery, partial severance, I had come to this. The passion was over now. I lit a match and put it to the corner of the letter; the flame was steady in the still air, golden and smoky-edged. The passion was over. I had repudiated it, and I should never feel it again.

Miles sees a human truth beyond the standards of science. Seldom has SF treated science this way—conveying the feel of dying loyalty to an ideal. Yet that's often what doing science is like.

After *The Search*, with its nostalgic farewell to the "passion" of research, Snow moved on to academic politics and the study of bureaucratic man, getting further from science as an electrifying process of discovery, and more into its growing role as the lever of government power. Thus it mirrors the lives of many scientists, reflecting the sobering fact that for most of us, the path to higher salary and greater influence inevitably leads us away from the primary experience that got us into science in the first place—the zest of discovery. (Or as the public would have it, instead of problem-solving nerds, we become paper-pushing nerds.) This bitter-sweet truth is one of the major facts scientists face, little understood by others. It intersects a further fact seldom rendered in literature: research as a group effort.

### The Talking Textbook

In detective stories there's often a dull, dour type



who clumps onstage solely to plant vital facts. This fellow, Dr. Dullard, tells us about ballistics, and why there is no safety on a revolver, or how come Miss Featherweight's dainty pistol couldn't have made those foot-wide holes in Mr. Drool. In SF, he's the scientist.

For similar reasons. Most SF uses scientists to yammer on in their own jargon, lending weight to the often comic book action of the main characters. Asimov's Hari Seldon was one such; in fact, he's literally dead while he goes on and on about how sociology is an exact science. At least in the murder story, the technical talk relates to human passions; in SF, the technopatter can be about something as bloodless as whether or not a match will stay lit in an orbiting spacecraft.

Fred Hoyle used many of C. P. Snow's techniques in SF, notably in *The Black Cloud* (1957). There's the same Cambridge background, the British mannerisms, and despite the occasional mainstream feel, Hoyle's scientists too often turn into talking textbooks. Why? Partly because Hoyle loves to pour on the technopatter. It's the real thing, too, not mere sauteed jargon covering a bed of baloney. But his people seldom come to life, perhaps because the central figure in a Hoyle novel is Hoyle himself—irritable, contemptuous of bureaucrats, lightning quick, and slightly shorter than the others.

It's interesting to contrast Hoyle's more *Analog*-type scientists with another British SF author's image of them: James Ballard's passive, awed figures. They inhabit decaying landscapes (often Cape Kennedy) and can't let go of the icons of science—abandoned rocket pads, wrecked aircraft, laboratories filling with sand. Ballard uses scientists as the opposite of the assured, prattling textbook. Far from being endless lecturers, they are as laconic as Gary Cooper without being heroic. Their almost Lovecraftian bewilderment—none can explain the disasters that have befallen their world—fits comfortably into Ballard's imagery of western decline, defeat, and easy *ennui*.

Ballard's popularity in post-Empire Britain has trans-

lated poorly to the US; it's a heady, atmospheric wine that doesn't travel. American SF readers seem to want more positive figures.

### The Cocksure Crank

One reason people like science is that it appears to guarantee some kind of certainty. There is a long line of dead-certain protagonists in SF, from Heinlein's wise-cracking guys on the go, down to James Hogan's monomaniac heroes. The underlying notion is hardheaded Yankee pragmatism, not dreamy theoretical wistfulness. Listen to a near-SF novel of 1954—Maxwell Griffith's *The Gadget Maker*. It traces the life of an ordinary engineer who later works in the space program, and the emphasis is on the sheer hard labor:

He had learned to spell in spelling bees and not by looking at cute pictures of apples, cats, and dogs; he had learned to multiply by memorizing multiplication tables; he had never finger-painted or been encouraged to express himself or to cooperate with the group; he had never spent time in a classroom listening to phonograph records of fairy tales recorded by stars of stage, screen, and radio; and he was unaware of the serious damage to his psyche that sitting in a corner and wearing a dunce's cap had done.

... alone in an echoing dormitory, he felt a kinship with all the men who have ever toiled over books in lonely rooms. He felt akin to great men, great intellects, for unlike so many old drudges and inexperienced youths he did not believe creative men idled pleasantly and then, when the mystical spirit moved them, whipped out works of merit in short, furious bursts of easy inspiration.

You can hear the Scottish growl of John W. Campbell, *Astounding/Analog's* hard-nosed editor, behind every word.

Yet this is a forthright kind of assurance, not megalom-

mania. A largely unrecognized asset of science is that ordinary people, following the scientific method, can produce useful work. This is not true of artists, where advances come from the towering figures. This means the team player scientist is often a rather ordinary-seeming person, far from the lurid excess of the romantic Frankenstein or the antiseptic coldness of Edison. This is seldom seen in conventional fiction, with a few notable exceptions. In *Live with Lightning*, a novel that traces the career of a middling-good physicist through the great era of nuclear physics, an experimentalist says:

The white-coated scientist idea is all very well for drugstore chemists or advertising pictures, but here we use monkey wrenches, screwdrivers, lathes, and torches. If you have to get down on the floor, you get down on the floor.

Scientists are still not as lowly as engineers, of course. But as a senior physicist sardonically remarks, ". . . we service them with information . . . Put it this way—our attitude toward engineers is about the same kind of tolerant contempt that a \$25-a-week repairman in a service station feels for the millionaire whose Rolls he has just fixed."

American scientists often sprang from very practical motivations (Hubble started as a handyman). Many people still confuse engineering and research. This particular flavor is caught in Paul Preuss's novel about particle physics, *Broken Symmetries*. A character named Cy Sherwood becomes a noted scientist without ever passing a written exam. His talents emerged during some nuclear tests, when he would consistently win the betting pool over how strong the blasts were:

After half a dozen shots it became apparent that Cy Sherwood was going to win every time. His buddies refused his bets, so he told them his secret: he'd found out how much pressure it took to crush an empty beer can (using a medical scale and a

"prepared sample" can), and during the setup for each shot, he'd staked out half a dozen beer cans at known distances from ground zero. Then, after each test, he'd volunteer to drive the instrument recovery teams in, and as his jeep jounced along through the coral dust of some devastated islet, he'd observe what the blast had done to his beer cans. The degree of tin-can crushing as a function of distance allowed him to calculate the overpressure . . .

If Robert Heinlein had ever heard this story, he would have used it.

### As Scientists See Themselves

Because SF tolerated straightforward, guileless writing, many scientists with a hankering to write contributed to the genre. J.B.S. Haldane, Norbert Weiner, Leo Szilard, Julius Huxley—the list contains some formidable names. Unfortunately, they usually delivered strong, pertinent warnings delivered as from a pulpit. Few ever told us what they experienced. The astronomer Robert Richardson, an exception, remembers how it felt to show others the stars in a planetarium:

It was thrilling to have the heavens at your fingertips. For a brief hour you were superior to ordinary mortals. He had become so used to moving the planets and stars in the planetarium sky that often he felt the real heavens were his to command as well. Somewhere there must be a switch that would make the moon and Mars leap at his bidding—if only he could find it.

That's a key emotion—the sensation that knowledge is power. And as Bob Shaw notes in his remarkable portrait of a scientist who learns how to defuse all nuclear arms, *Ground Zero Man*:

Accompanying the flash of inspiration was a semimys-

tical feeling that he had been chosen, that he was the vehicle for another's ideas.

This is the direct experience of doing science. I find it the hardest kind of writing to do. One of my favorite passages from my own work comes from a chapter in *Timescape* (1980), which deals with a physicist sitting in a transatlantic flight, doing a calculation:

Galileo's blocks gliding across the marble Italian foyers, their slick slide obeying inertia's steady hand—they were cartoons of the world, really. Aristotle had understood in his gut the awful fact that fiction ruled, all things groaned to a stop. *That* was the world of man. Only the childlike game of infinite planes and smooth bodies, reality unwrinkled, cast a web of consoling order, infinite trajectories, harmonic life. From that cartoon world it was always necessary to slip back, cloaking exhilarating flights in a respectable, deductive style. But that did not mean, when the papers appeared in their disguise of abstracts and Germanic mannerisms, that you had not been to that other place, the place you seldom spoke of.

### Beyond Science

Poul Anderson once said that he saw himself as a bard of the sciences. That is a workable definition of SF's role in society, I think, and it's tough. Seen from the outside, a scientist need not be any more interesting than a bank clerk. At least the reader does not struggle to understand what the clerk is doing. (T.S. Eliot wrote some of his great, bleak verse while canceling vouchers and doing sums, and one can well wonder how that affected his poetry.)

The apparent dullness of scientists may be superficial, but several SF writers have suggested that it is a fundamental limitation. In Raymond F. Jones's short story, "Noise Level" (1952), a group of scientists is shown a film of an apparently bona fide working anti-

gravity device. The inventor has been killed, the machine lost. They are urged to duplicate it. After some striving, they do indeed break through into a new understanding of basic physics. Only later do they learn that the film was faked. It was contrived to break down the conventional mind set and stir imagination. Ordinary science, Jones says, is too ordinary for its own good.

Occasionally, SF has thought about societies that have an entirely different attitude toward science. John R. Pierce, a noted physicist, described a world where doing science at all was morally tainted, in a 1962 short story, "John Sze's Future":

And to use the expression *nuclear physicist*, why, that was worse than *reactor engineer*. Crawdon called himself a natural philosopher. One might have to do what he did for society, but there was no sense in calling it by a dirty name.

Scientists are members of a low caste, since they are held guilty for various nuclear accidents of the past.

So we return to scientists as the defendant, little better than Dr. Frankenstein. No matter how many posters of Einstein you see in the rooms of undergraduates (often sticking his tongue out), this beatific image isn't the dominant face we scientists present to the world through general literature or even SF. I've found that many intelligent people *do* think that beneath our outwardly benign manner there's a bit of power madness, a love of our subject beyond the bounds of good judgment, a tendency to push an area of study because it is—in Oppenheimer's phrase—"technically sweet."

Many of us SF writers have devoted energy to showing scientists as real folk—maybe not ordinary, granted, but understandable. That message is quite slow in getting through. Many intelligent people feel that, down deep, they're Not Like Us.

Sometimes I think this level of mistrust is inevitable. We do drive the world onto new ground, where the

footing is slippery. We can scarcely expect rave reviews for that. But if SF continues to deal realistically—not romantically, not hysterically—with science, perhaps matters can get better. In the end, that may be our most important legacy.





## *Introduction to* **THE PHOBOS RACE**

*A remarkable change of heart has occurred. Public Voices who have never had a good word to say for manned space are suddenly hot for a joint US/Soviet Mars mission. Why is that? How would such a mission differ from Space Station, or Shuttle, or Space Lab?*

*Two ways that I can figure: 1) It would siphon off virtually every government penny otherwise available for building near-earth infrastructure into a "moondoggle" with virtually no post-mission benefits, and 2) it would have Russian scientists and KGB operatives (there's a difference?) crawling all over our Space Program.*

# THE PHOBOS RACE

*Donald Fredrick Robertson*

For there to be a race, do both contestants have to know the objective? Or even that a race is, in fact, being raced?

Most Western studies on the future of human (as opposed to automated) solar system exploration have applied technology developed in the twenty-plus years since Apollo designs were frozen to reduce the costs of more or less traditional goals: a Lunar base, human Mars missions, or asteroid mining. Recently, however, three men—a man space historian Tim Kyger refers to as “one of America’s astronautical pioneers,” a former astronaut, and a planetary scientist—have all begun to advocate a new post-Space Station goal.

This goal is one they believe will be much easier to accomplish than any of the older projects, and thus more likely to win political approval in this age of limited budgets. It would combine into a single project the traditional aims of the scientific exploration of the solar system with the newer ones of space industrialization, thereby enlarging the constituencies of both. And it would be a significant step toward that ultimate goal, the beginnings of solar system trade.

This new goal is the human exploration and exploitation of Mars’ two small moons, Phobos and Deimos. In

terms of total velocity change, these bodies are essentially the easiest of solar system objects to reach from Earth orbit. The realization of this single fact could allow the early establishment of a solar system economy based on the low-cost delivery of water and fuel from these moons to industries in Earth orbit and eventually on Luna—perhaps as early as the turn of the century.

Six years of paper studies by these three scientists appear to have been largely ignored by NASA. They may not have been ignored elsewhere.

At the 16th annual Lunar and Planetary Science Conference in 1985, the Soviet Union chose to dump a decades-old tradition of absolute prelaunch secrecy on automated solar system exploration. At a conference attended by the cream of Western space scientists and management, Soviet scientists described in unprecedented detail a 1988 mission to none other than the Martian moon Phobos.

Water—for life support, rocket fuel, and industrial processes—is the single most important resource required for the colonization and industrialization of the inner solar system. It is also the heaviest. And worse, down here close to the Sun, it is a very precious commodity, either locked up at the bottom of massive gravity wells (Earth, Mars) or entirely absent (Luna). To find an almost infinite supply, at less delta-V (the sum of all the changes in a spacecraft's velocity required for a given mission; in this case, a measure of its cost) than any other source regularly available from low Earth orbit, is a miracle which could mean the difference between space industrialization in our lifetimes—or never.

Yet S. Fred Singer, former astronaut Brian O'Leary, and planetary scientist Bruce M. Cordell believe they have found just that.

If it were not for their circular, equatorial orbits, it would be easy to conclude that the Martian moons are captured asteroids—and many scientists do anyway. Both are small and very dark; both are saturated with craters

blasted into ancient regoliths; both maintain the same face toward Mars, with their major axes aligned toward the center of the primary.

In other ways, these asteroid-moons are very different. On a small scale (hundreds of meters) Deimos appears rougher than Phobos, while on a larger scale, the opposite is true. Phobos is wracked by what appear to be cracks a few tens of meters deep and hundreds wide, possibly resulting from an ancient impact which blasted a crater nearly a third as wide as Phobos's longest axis. Crater counts suggest the surfaces of both moons are on the order of three billion years old.

Phobos's orbit is believed to be decaying at a rate which will result in a Martian impact in a few tens of millions of years; Deimos is very close to Mars's geosynchronous orbit and moves very slowly through the Martian sky—making it potentially very valuable real estate, as we shall see.

But the main value of these bodies lies in their estimated composition, which is similar to carbonaceous chondrite meteorites or C-type asteroids; that is, rich in hydrated silicates and carbon, as well as limited amounts of metals.

Water content could be as high as 20 percent.

Evidently, the idea was first taken seriously at the first Case For Mars Conference in Boulder, Colo., sponsored by a group of students and held from 29 April through 2 May 1981. (The papers have been published by the American Astronautical Society in Volume 57 of its Science and Technology Series).

S. Fred Singer, originator of the Minimum Orbital Unmanned Satellite of Earth (MOUSE) proposal of 1953, based on earlier British Interplanetary Society work, presented a paper entitled "The Ph.D. Proposal: A Manned Mission to Phobos and Deimos." Therein he argued that, even for purely scientific missions, it made more sense to send a human crew to Deimos than it did to send either automated or human missions to Mars itself. He felt the high cost of sending a human mission

to the planet, involving the development and transportation of landing vehicles, would make near-term approval unlikely, while automated missions are very limited in the science they can obtain—and are not at all *that* cheap, in any case.

But what could humans do for science on Deimos? Well, first there's Deimos itself. Thirty years after the beginnings of the space age, Comet Halley is the only one of the solar system's small bodies humanity is attempting to explore—despite the fact that these bodies could be of the highest long-term importance, both for science and potential industrialization. [As I write, NASA Administrator James Fletcher has declined to request the CRAF Comet Rendezvous and Asteroid Flyby mission for Fiscal Year 1988, favoring instead international Earth-orbital projects to map yet again (albeit in greater detail) Earth's radiation belts and ocean surface topography. Both of these are worthy scientific missions, no doubt, but beyond their obvious military utility, I can't help wondering what they will do to advance humanity's long-term future in space.]

The biggest problem with automated rovers on Mars is the time it takes for a signal to reach Mars and return to Earth, requiring rovers to be highly autonomous and therefore expensive. Singer suggests that a Deimos base would allow essentially real-time control of therefore relatively simple (and therefore inexpensive) rovers and sample return vehicles. Deimos presents a single face to Mars, allowing simple placement of communications antennae, and is in a close-to-geosynchronous orbit, allowing long communications sessions with Mars-based assets. This, in turn, says Singer, allows proliferation of those assets: a Deimos mission would allow "the *sequential* operation of *many* rover vehicles at different locations on the surface of Mars in a *single* space mission, thus increasing the probability of discovering scientifically exciting results" at less cost than flying and controlling a similar number of rovers from Earth (emphasis on original). A further advantage would be the effective quarantine of samples

and personnel at the Deimos base, reducing the risk of back-contamination of Earth by still barely possible Martian organisms.

Carl Sagan, meanwhile, has pointed out to Brian O'Leary that telescopes on Phobos and Deimos could easily provide a resolution on Mars ten times superior to that of the Viking cameras, and could define the most interesting locations for sample returns and later human landings. O'Leary also quotes S.J. Adelman and B. Adelman as stating at the second Case For Mars Conference in July 1984 that a Phobos base could also support gravity-wave astronomy, radio astronomy, and astrometry research.

Singer thus argued that automated Martian landings controlled from Deimos are easier, less costly, safer, and could be done much sooner than a human Mars landing. How costly? "Assuming that certain development costs can be shared with other programs, the incremental cost . . . is estimated at less than \$10 billion (in 1978 dollars) over a fifteen-year period," says Singer.

If Phobos and Deimos can be all that advantageous and inexpensive for purely scientific pursuits, what might they do for the quest to find ever-cheaper resources for proposed Earth-orbital industries? It did not take Brian O'Leary and Bruce Cordell long to find a very favorable answer.

About this time, aerobraking, the science of using a planet's atmosphere to take orbital energy from a spacecraft, was coming into vogue as a way of reducing the high fuel costs of Earth-orbit Orbital Transfer Vehicle operations. Since velocities into the Martian system are always less than those involved in cis-Lunar space, it did not take much imagination to realize that any aerobraking OTV developed for Earth-Lunar or Earth-geosynchronous transportation (it is actually easier to get to Luna than it is to get into geosynchronous orbit) would be applicable to entering Mars orbit from an interplanetary trajectory.

According to O'Leary, aerobraking at Mars can re-

duce propulsive delta-V requirements from 1.5 or 2.0 kilometers per second to 590 or 667 meters per second for Phobos and Deimos respectively. However, "even without aeroassist at Mars, the moons of Mars are more accessible to the Earth at biennial opportunities than is the Moon of the Earth. The chief difference is in the requirement to soft land payloads on the Lunar surface. . . . [Further,] the [Phobos/Deimos] missions permit low-impulse propulsion for the entire trip, opening the possibility of using solar electric, mass-drivers, tethers, and solar sails as sources of propulsion. The only advantages the Moon seems to offer are its proximity and launch window frequency: days versus months or years" (National Academy of Sciences/NASA Symposium on Lunar Bases and Space Activities in the 21st Century).

But Bruce Cordell has gone even further. In a report done for a large U.S. aerospace company, Cordell considers three classes of human missions: a human mission to the Martian surface in the absence of any "significant" Lunar utilization; human missions to Mars after the establishment of a lunar base; and the possibility that "the next major post-Space Station civilian goal in space for the United States (and its collaborators) should be the exploration of the Martian moons. This program should occur prior to, or at least concurrently with, the development of any Lunar industrial capability."

Cordell lists many of the same advantages for early Phobos/Deimos development as O'Leary, including regular launch windows, as opposed to asteroids; round-trip delta-V's which "compare favorably with those to any asteroid;" the fact that Phobos and Deimos have "better specified physical and chemical properties than currently known Earth-approaching asteroids;" and potentially of greatest importance, "propellant production plants on Phobos/Deimos . . . make the manned landings on Mars independent of terrestrial fuel supplies."

This could be very important because, on Mars, "the existence of crustal swells, rifting, volcanism, impact cratering, and abundant water . . . ; [possible] hydro-

thermal, dry-magma, and sedimentary mineral concentration processes . . . [and] tectonic similarities between mineral-rich Africa and portions of Mars, suggest that the potential for mineral wealth on Mars is impressive." Any such minerals would reside within Mars's relatively small gravity well, making their use by space-based industries less expensive than Earth-derived materials.

The main emphasis of Cordell's study was the development of an economy based on the mining and transport of water from these moons. The first human mission of the Martian system, under Cordell's plan, would take place during the 2001 window, although he can find no reason why that should not happen earlier. In fact, he told me he now considers his entire argument to be far too conservative.

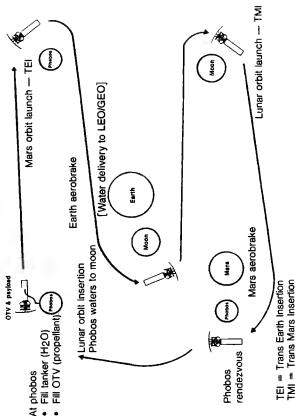
In order to keep this first interplanetary mission simple (and thus inexpensive), Cordell proposes an unusually small crew of three, one of whom would be a geologist.

The 2001 mission would use two reusable Orbital Transfer Vehicles stacked one on top of the other into a single spacecraft. All the fuel of one and 30 percent of the fuel of the second would be used to get to Mars, with aerobraking in Mars' atmosphere used to slow the remaining vehicle. Sixty days would be spent remote sensing, mapping, probing, and sampling both Phobos and Deimos. The spacecraft then would return to Earth via a Venus swingby, and would maneuver to rendezvous with the Space Station. (Alternatively, aerobraking in Earth's atmosphere could replace the Venus swingby, resulting in a shorter travel time but at the price of heavier aerobraking equipment.) Total delta-V for this round trip is 7.91 kilometers per second—compared to 9.0 to and from the Lunar surface.

Using the information obtained on this mission, "intense" research and development on obtaining water and OTV fuel from Phobos/Deimos regolith material would be undertaken. In 2005 a second human mission would continue the exploration begun on the first mission, and would begin initial work on a base on one of



# ADVANCED MOON — PHOBOS WATER RETRIEVAL MISSIONS



the moons, or a rotating orbital station, depending on human zero-gravity endurance. The crew of this OTV would remain in the Mars system, to be relieved at the next Mars window, two years later. Including travel time, each crew would spend approximately four years in space, which, according to James Oberg, would result in sufficient radiation exposure to limit each crew to a single mission.

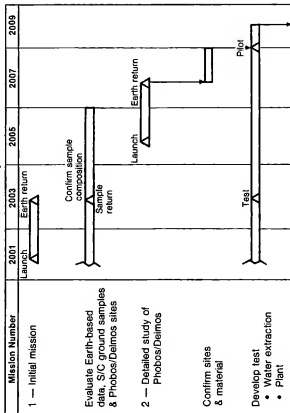
Following construction of what Cordell describes as humanity's first base outside the Earth-Moon system, a new class of automated OTV optimized for water transport would arrive, to be loaded with water mined from Phobos or Deimos, and then head back for Earth orbit or any Lunar base. Phobos/Deimos-Luna transport loops require about half the total delta-V of Earth surface to Lunar surface loops. "This is due to the large ascent requirement for Earth; from Earth to low Earth orbit it is 9.7 kilometers per second." Keep in mind that the Phobos/Deimos loop was 7.91 kilometers per second. It could be less expensive to fuel cis-Lunar OTVs from the Mars system than it would be to deliver the fuel from Earth, and certainly "all necessary propellants—for both the Mars-bound and Earth-bound portions of [water transport flights]—are produced completely from water extracted from the Martian moons."

Soviet space officials may have read all this with more than academic interest, for in a period of time after Singer's original paper that was suspiciously close to the time required to develop an automated mission, the Soviets revealed their surprise in Houston.

The Soviet Phobos/Deimos spacecraft will be based on the well-demonstrated Venera spacecraft, but will incorporate major improvements. It will be launched in 1988.

Dr. Valery L. Barsukov of the Vernadsky Institute, and other Soviet scientists, said two spacecraft will be launched toward Mars. Upon arrival, one spacecraft will approach Phobos and stand fifty to one hundred meters off its surface. High-powered laser and ion beams

# **SAMPLE MARS EXPLORATION PROGRAM** **Phobos/Deimos Emphasis**



# **SAMPLE MARS EXPLORATION PROGRAM (continued)** **Phobos/Deimos Emphasis**

Mission number	2001	2009	2011	2013	2015
<p>3 — Establish permanently manned base on Phobos &amp; Deimos; activate water processor; remote Mars science</p> <p>Develop &amp; test</p> <ul style="list-style-type: none"> <li>• Propellant processing</li> <li>• Facility</li> </ul> <p>4 — Establish propellant processor; station crew recycle</p> <p>5 — Phobos/Deimos resource exploration &amp; utilization; site selection for manned Mars landing/bases; station crew recycle</p> <p>6 — First manned landings on Mars</p> <p>7 — Initial Phobos/Deimos volatile retrievals to Moon &amp; LEO</p>					

will lance down to vaporize part of the regolith, and instruments on the spacecraft will measure the composition of the resulting gas.

According to *Aviation Week and Space Technology*, the main spacecraft may also drop a small lander which "will have the ability to hop across Phobos's surface, returning pictures and other data," including a seismographic "thumper," a magnetometer, and an x-ray fluorescence spectrometer for surface chemical analysis.

This is exactly the instrumentation required to conduct geochemical "prospecting" for potential resources. Dr. Andrew Hall Cutler, then a research associate of the University of California's California Space Institute, told me he expects the Soviet gamma ray detectors for their proposed Lunar Polar Orbiter to be technologically limited to a resolution similar to that obtained of the equatorial regions of the moon by Apollo. However, since the Phobos spacecraft will be closer to the object it is measuring, this may not be a significant problem when the instrument is used at Mars. In any case, Western research has demonstrated that even Apollo's relatively coarse measurements provided information adequate to conduct many preliminary studies on lunar resource distribution.

If the first mission is successful, the second spacecraft may conduct a similar analysis of Deimos; otherwise, a second attempt will be made at Phobos.

These spacecraft will also have cameras and other instruments for orbital reconnaissance of Mars similar to that accomplished by the Viking mission.

A number of Western authors (notably former astronaut and Senator Harrison Schmidt) have continued to promulgate rumors suggesting the Soviets might attempt a human mission to Mars during the 1988-1989 window. This would be a good time for it: Solar activity is expected to be low, reducing requirements for all-important radiation protection. This is also said to be one of the "easiest" windows to Mars for the remainder of the century.

I, however, doubt the Soviets can have their act sufficiently together to make that window. The Soviets *never* do "all-up" space testing—all at once with everything having to work the first time, the way the Space Shuttle was tested. Soviet "man-related" spacecraft are tested and tested again under the "Cosmos" designation, generally over a period of five to ten years, before they are flown with humans on board. In the entirety of Soviet spaceflight, they have "man-rated" a grand total of *one* launch vehicle—the very one which in a simpler form launched Sputnik-1 thirty years ago! Based on past practice, the Soviets may be expected to spend the better part of a decade conducting automated testing of developmental trans-Mars spacecraft in Earth orbit, then on Earth-Mars trajectories, before attempting a human mission. The latter tests are certainly not yet happening.

Other infrastructure requirements are not obviously available. The Soviet Saturn V-class launch vehicle, well-nigh essential for practical Mars missions, is reported in the aerospace trade press to have been repeatedly wheeled to and from its launch pad since it was first noticed in observation satellite imagery. This has been interpreted as an indication of development problems.

But even were the vehicle to be launched tomorrow, it seems unlikely the Soviets would use it for something as important and risky as human interplanetary flight as early as 1989. Logistic requirements suggest to me the vehicle is unlikely to be launched more than two or three times a year, at least for the first few years. The maximum rate ever achieved for the U.S. Saturn V was a bit under six times a year, according to Kyger and two or three times a year was more common. These numbers, however, are heavily dependent upon the number of pads and manpower assigned to the project. But assuming the Soviet vehicle must be launched a number of times before any payload, let alone an important one, is to be risked, time is clearly running short.

Finally, and most importantly, cosmonauts have yet

to demonstrate the zero-gravity endurance required. Any chemically propelled mission which does not involve actually landing on Mars will expose crews to around two years of zero-gravity. To date, the Soviets have demonstrated only two-thirds of a year—and that, rumors suggest, at a non-trivial debility to the cosmonauts involved. The Soviets have been flying about one long-duration mission per year, and increasing the length of each record-breaking mission by increasingly small increments; and further, flying a greater number of missions of duration less than the record. All this suggests to me there may be insufficient time to demonstrate two-year zero-gravity endurance by 1989, and the Soviets have tested no rotation-induced artificial gravity structures to date.

It should, however, be pointed out that the Soviets do have as good a start as the United States on aerobraking technology. Their Zond circumlunar experience is as relevant as Apollo experience to this problem.

Upon reading an early version of this article, Brian O'Leary commented that I "have emphasized competition with the Soviets. [He would] also acknowledge efforts to cooperate with them for balance." I'd like to. The problem is that as far as I can see, all the efforts at cooperative human Mars missions come from one side—American scientists. The Soviets have either flatly turned down or rebuffed every recent proposal of which I am aware. Soviet scientists might want to cooperate in space development, but the people who make the decisions clearly do not. The same would appear to be true of American decision-makers.

Then why the sudden change in a policy of secrecy as old as the Soviet space program itself?

At the same meeting where they announced their Phobos/Deimos mission, the Soviets also announced current construction of an automated Lunar Polar Orbiter, and an automated asteroid landing mission awaiting approval. Again, the targets for these missions are very suggestive. After over a decade of exclusive con-

centration on Venus, why this sudden expansion of the repertoire?

A new-found confidence leading toward ambition is surely part of the answer to these questions. The Soviets have flown ever more ambitious missions to their "preserve" at Venus without a single complete failure since the launch failure of Cosmos-482 in 1972. So a decade after their politically humiliating but technically important failures at Mars, the Soviets are ready to try again with a mission at least potentially capable of outperforming Viking.

Another part of the answer may be long-term Soviet ambitions. The Soviets may have come to recognize that they cannot hope to compete with United States technology and management skills in any all-out race, and they may further reason that Western knowledge negates Western surprise. It was public surprise at Sputnik-1 which pushed the United States into the Apollo program. If the Western public *expects* the Soviets to undertake the incremental steps leading to development of the Inner Solar System, that public should not be surprised when each step is accomplished, and thus might not goad its leaders into competition the Soviets cannot afford.

By the time the Inner Solar System was occupied, it would be too late, and the Soviets would have won the only game which in the long term matters.

The civilizations of the future would speak Russian.



*Introduction to*  
**TEST FOR TYRANTS**

*As much as we would like the world to be otherwise, there are times when even decent people must behave indecently—even if it means victimizing an innocent tyrant.*

# TEST FOR TYRANTS

*Edward P. Hughes*

Liam McGrath lay beside his sleeping wife, trying to plan. Already, dawn brightened the corners of the bedroom. In a few hours, Father Con would be saying the words to make Brege O'Malley wife of Christie Kennedy—and thus pose a problem for the new Lord of Barley Cross.

Liam shifted restlessly. What would the O'Meara have done about it? Liam recalled very clearly what the previous Master had done after his, Liam's, wedding. But the O'Meara had ruled Barley Cross for longer than Liam could remember, and Liam, fresh to the job, could not hope to match such expertise.

At six o'clock he reached a decision, and got up. He dressed without disturbing Eileen, and slipped out of the Fist by the bedroom window and the secret path through the kitchen garden.

At the foot of the hill, he turned river-wards, making for a lonely cabin which stood just off the track leading down to McGuire's mill. It was light enough to see that he had the road to himself. A raw wind blew promising rain. Typical Connemara wedding day, Liam reflected.

The cabin was in darkness. He rapped, not loudly, but persistently. A light flickered behind the curtains, a bolt rasped, the door opened an inch.

"It's me, Liam," he hissed. "I need your help, Katy."

He heard a sigh of exasperation. "Liam McGrath—you may be our new Master, but it doesn't give you the right to get an honest whore out of bed at six in the morning."

"Let me in," he pleaded. "I've got to talk to you."

He caught a giggle. "Well, so long as it's only talk you want . . ."

A chain rasped, and the door opened wide enough to admit him. Kate Monaghan, in curlers and a red flannel nightie, peered at him in the lamplight. "You'll be getting a worse name than the O'Meara," she warned. "At least *he* abstained from commercial fornication."

Liam closed the door behind him. "No one saw me, Katy." He shrugged off the overcoat he had draped over his shoulders. "I put this on to alter me appearance."

She set the oil lamp on a table. "If you think that old rag can hide our new Master—"

He sat down, breathing heavily. "Can't be helped, Katy. I had to see you. I need your help."

She said, "I'll put the kettle on. We'll have a cup of tea while you tell me your troubles."

As she poured, he blurted, "Brege O'Malley gets wed today. And I've got to do my *droit du seigneur* thing with her tonight."

"Droyt doo what?"

He explained.

She raised her eyebrows. "Sure, that shouldn't be a difficult job for a fine upstanding young fella like yourself."

He sighed, seeing suddenly a vision of Brege O'Malley. Saint Brege, the Ice Maiden, they had christened her as children. Twelve months younger than Liam, she, Christie Kennedy, and the other educable infants of Barley Cross at that time, had squeezed together into the too-small desks of Celia Larkin's one-room school. Brege, even then, had affected piety—wearing below-the-knee skirts, aping the habits physical and moral of

the nuns she claimed she would have joined, had there been a convent handy.

"Well?" It was Katy, bringing him back to the present.

He lifted his head. Now that he needed to keep awake it was a job to hold his eyes open. He began diffidently, "I— er—" The trouble was, Katy Monaghan might be one of those Barley Cross citizens, like his stepfather, who accepted all they were told about the Master. He plunged on recklessly. "I don't know how much you know about the Master's responsibilities—?"

A furrow appeared between her eyes. "I know enough to agree that you ought to get on with your droyts, if that's what's mithering you."

Katy would, of course. Being a harlot, a droyt or two would be neither here nor there to her. He sighed. "It ain't that, Katy. It's what Christie Kennedy will want to do about it."

"Bugger Christie Kennedy," she snapped. "Just get your guards to throw him out if he shows up."

Liam shook his head. "That would only make things worse. I've got to let him into the Fist and face him on my own. Try to talk him out of killing me."

Her eyes opened wide. "Would he try to do that?"

Liam shrugged. "I tried to kill the O'Meara when I got wed."

She said briskly, "Then you must kill Christie first."

Liam groaned. "I can't do that. If I took a life each time I tried to start one, I wouldn't be much benefit to Barley Cross, would I?"

She nibbled at her bottom lip, studying him in silence. "So that's the reason why the O'Meara bedded every bride in Barley Cross? Well, bloody well! And what can I do to help you?"

Liam raised his eyes, face haggard. "Has Christie Kennedy ever visited you . . . in your professional capacity?"

Kate Monaghan regarded him archly. "Liam McGrath—would you be asking me to break my hypocritic oath? Sure all my business is confidential."

His lip trembled. "Knock it off, Katy. I'm serious."

She whispered, "And what if Christie did come to see me?"

"I—I could threaten to tell his wife."

Her eyes grew wide. "Glory be to God! And on his wedding day, too! And you the Lord of the village, who should be setting us all an example!"

"You don't understand, Katy," he pleaded. "It's only because I'm Master that I have to blackmail him."

She eyed him narrowly. "And just where would I come in?"

Liam peered around the edge of the curtain into the brightening daylight, as if half afraid that an eavesdropper crouched outside. He said, "I want you to come up to the Fist for the day."

She stared. "And what would your wife say? She knows what I am. Sure, she wouldn't let me past her front door."

He wanted to contradict her, but knew it would be a waste of time. All Barley Cross knew that Kate Monaghan was a loose woman. The women tolerated her, as they tolerated the lewdness of the Master, in grim silence. His Eileen would probably slam the door in Kate's face.

He mumbled. "My wife won't be there. She's taking the baby and herself off to her mam's for the weekend, so that, officially, she won't know what goes on at the Fist."

"Oh? And what does go on at the Fist?"

He moaned. "Christ, Katy—don't you understand? I've got to take Brege O'Malley to bed, and try to get her in the family way. And Christie Kennedy will probably climb in through my bedroom window and do his damndest to stop me."

She nodded thoughtfully. "I see. And just as he's going to stick a knife into your pelt, I bust out of the wardrobe crying 'Halt, Christie Kennedy! Or we'll tell yer new wife all about the antics you got up to with me last summer?"

"Something like that," he agreed lamely. "It's the best I can think of. The O'Meara would have had a smarter way of doing it, but I'm not the O'Meara."

"And thank God for that!" Her eyes flashed angrily. "The O'Meara would never have taken me into his confidence. I may not set a shining example in the village—but I'm as loyal a citizen as any of 'em."

He said startled, "Then you'll come?"

She flourished a fist. "Just tell me how to get past yer guards."

General Desmond was hovering in the hall when Liam returned. "Where've you been?" he demanded ungraciously. "You're supposed to be at the church by nine o'clock."

"I've been attending to the Master's business," Liam retorted, concealing his awe of fierce Larry Desmond, but still unsure how far he might verbally venture with the old soldier.

"I've an Honour Guard picked for your escort," the general continued, as if Liam had not spoken. "Two of our smartest men, and a corporal to carry the presents and deliver the summons. We're sending the bride a tablet of soap and a bottle of perfume, and the same to her ma. It's more than usual, but we want to build you up as a generous tyrant."

"So pleased—" Liam began.

"And Michael has pressed your uniform."

Liam sensed his ears prick, like a rabbit's. "Uniform? I have no uniform."

The general smiled genially. "The O'Meara used to wear his old Coldstream Guards outfit at functions. If we pad the chest out a bit it'll fit you good enough."

"But I've never been in the army," Liam protested. "I'm not even old enough to serve at the Fist."

"Ach, away with you!" The general waved a carefree hand. "What's the use of being Master if you can't bend the rules occasionally. You've got to look impressive today."

Liam took a deep breath, knees quivering. It was now or never—unless he intended to knuckle under to Larry Desmond for the rest of his life. "No uniform," he stated firmly. "Positively no uniform. I'll wear my best suit, if you like. But no uniform."

General Larry Desmond's white eyebrows bristled. "Now listen here, young Liam—!"

"*Master!*" Liam corrected, holding his lips firm. "Master of the Fist and Lord of Barley Cross."

General Desmond looked straight at him, as if seeing Liam for the very first time.

Liam stared back, without speaking.

The general seemed to shrink slightly. "Okay, me lord," he conceded. "No uniform. Your best suit will do nicely. And would you condescend to attend at the reception after? You need only stay for the meal and a couple of dances."

"I'll do that," Liam agreed. "I'll even wear some kind of badge or chain of office, if you can dream one up."

Larry Desmond brightened. "Now there's an idea." He rummaged in his pocket. "Pat used to wear an old medallion around his neck. I was keeping it as a souvenir." He pulled the hand from his pocket and offered Liam a chain. "Perhaps you'd—?"

Liam took the chain, and examined the silver disc attached to it. One side of the metal bore the figure of Saint Christopher, the other the words P. O'MEARA, KILCOLLUM, CONNEMARA. Liam slipped the chain over his head. "Let's call it my chain of office."

"Thank you," said Larry Desmond. "Maybe you'll make a decent Master yet."

Liam arrived purposely late, and lingered at the back of the church. He was not keen to meet Father Con's accusing eyes over the head of the bride he intended to force into adultery before the day was out.

Later, at the reception, he found himself given a seat of honour beside the bride's mother, and was obliged to attempt polite conversation with Ma O'Malley.

She leaned confidentially toward him. "Will you be sending for our Brege tonight, me lord?"

Liam pondered the tone of her voice. Was she hoping that he'd say "yes"? Women were mysterious creatures. Since his accession, he had discovered more mild-looking, middle-aged matrons in Barley Cross who secretly approved of the O'Meara's carnal excesses than

he could have ever imagined. He murmured, "My corporal has the summons in his pocket. Will Brege be willing?"

Ma O'Malley eyed him coquettishly. "Don't you be worrying about our Brege, me lord. I'll see she's willing. And, if she ain't, dammit if I don't come up to the Fist meself in her place!"

Liam tried not to flinch. He sneaked a glance along the table to where Brege's father, Pete O'Malley, was tucking into turkey. Liam whispered, "I hope you don't let Mister O'Malley hear you make remarks like that. Not that you wouldn't be welcome," he added gallantly, "but it's Brege's turn this time."

When Franky Finnegan struck up a waltz on his fiddle, Liam found the nerve to plunge into the prancing throng, his arms around his hostess. Ma O'Malley danced enthusiastically, as if determined not to waste an instant of the glory in the new Master's embrace. Liam sweated, counting beats under his breath, accommodating his stance to the O'Malley figure.

Two dances, Larry Desmond had stipulated. The next one, then, had to be with the bride. As Franky finished with a flourish, Liam released his partner and glanced around the floor.

The new bride stood momentarily alone, her husband heading for the bar. Liam excused himself, and headed toward opportunity. Franky struck up again, and he led the Ice Maiden, unexpectedly gorgeous in long white satin, onto the floor.

She murmured, "So kind of you to come to my wedding, Master. And thank you for the presents."

Since fine quality toilet soap and French perfume had not been seen in Barley Cross for years, except on those occasions when the Master showed his generosity, Liam reckoned she meant it. He cracked a grin. "Liam's the name, Brege."

She pouted. "But you are Master, too."

"But still Liam McGrath," he countered. "I hope I haven't changed."



She smiled nervously, nodding at the medallion. "Would that be your chain of office?"

He flicked it with his thumb. "It belonged to the O'Meara. General Desmond thinks I should wear it."

"Then it is to show us you are the Master?"

He was getting fed up with the way people harped on about it. He said curtly, "If you like."

She lowered her head, her voice almost inaudible. "Does that mean you'll be sending for me tonight?"

In his confusion, he trod on her foot. God! Was the Ice Maiden seeking a summons? He opened, then shut his mouth. Couldn't ask questions like that. In a carefully neutral voice he asked, "Did you not get the summons yet?"

She shook her head, mute, waiting for him to invite her personally. He couldn't speak. His tongue was swollen and dry. He scanned the crowd, seeking the corporal. When was the man supposed to deliver the summons, anyway? Had he forgotten it? And everyone wanting to know. The reception was turning into a bloody shambles. Liam choked, flushed, then managed to say, "Excuse me—got to see my corporal about something."

He released her, cast aside manners and propriety, and pushed blindly off the dance floor. Damn everything! He couldn't face Brege's mute curiosity. He ran from the hall, ignoring the startled glances of other guests, heading for the Fist, hating Brege, hating General bloody Desmond, and most of all, hating himself.

He found the general in his parlour, with Kevin Murphy, the vet. The general waved cheerily. "You survived the ordeal, then, me lord?"

Liam held tight on to his temper. "Just when is that corporal supposed to hand over the summons?"

The general frowned in thought. "I told him to hang on until the 'do' had quietened a bit. Lot of people leave early. Didn't want to upset too many folk if they didn't like you emulating the O'Meara."

"Oh!" Liam's anger drained away. As usual, the general had acted for the best. He said, "Well, he was still

hanging on to it when I left, and the O'Malley women are going nuts waiting. I got the impression that Brege expects to be summoned. Her ma is all for it."

The general nodded. "Just as well. If the young lady should refuse, you could clap her parents in jail until she changed her mind. We did that once, early on, Kevin—remember?"

Kevin Murphy nodded. "Niver a bit of trouble in Barley Cross after that. Might be a good idea to throw somebody into the cooler right now. 'Twould establish Liam's authority for sure."

The general rubbed his chin reflectively. "Young Kennedy might be a suitable candidate. It'd keep him out of the way, too." The general considered Liam. "We can't maintain a permanent guard on your bedroom, unfortunately. It could mean telling them too much. But if you have any trouble with young Kennedy, Kevin and I will be standing by. Just ring for Michael and we'll come running."

Liam hid his embarrassment. Thank goodness he had kept his feelings about the general to himself. He murmured, "Thank you, gentlemen. I'll keep it in mind."

A cool breeze wafted through the open window. Liam sat by the bed, one hand gripping the O'Meara's heavy old revolver concealed beneath the counterpane. Christie Kennedy must surely have heard the news by now. Michael had reported the Honour Guard's return over half an hour ago. Was Christie shirking it? He had always been a bit of a blowhard at school. But when your wife's honour was in question . . . ?

Something whizzed past Liam's head, and struck the wall behind him. He turned in astonishment. The feathered butt of an arrow projected from the plaster. He swiveled back to discover Christie Kennedy astride his windowsill, a stretched bow in his hands, and an arrow lined up on Liam's breastbone.

"Right, you bastard!" Christie gritted, swaying.

For a brief moment Liam considered, and rejected, the response the O'Meara might have made to that

epithet. But both he and Christie were bastards. And Christie was drunk, and probably immune to reasoning.

Liam moved to face him, coughing to hide the clink of the chain mail he wore under his shirt. "What do you want, Christie?"

Christie Kennedy's lip lifted in a sneer. "Only your signature on a bit of paper which says you cancel the summons your bloody corporal just gave my Brege."

Liam pondered. Christie's attention had to be diverted while he got the gun out of hiding. No arrow could penetrate his medieval underwear—but what if Christie aimed for the head? He needed outside help. Liam called softly, "Katy!"

The door to his private bathroom opened, and Katy Monaghen sauntered into the bedroom. She wore bright red brassiere and briefs. A black satin suspender belt supported a pair of black stockings which left on show the top six inches of her creamy thighs. A red satin rosette decorated her right knee.

"Hi, Christie!" she called.

"Jesus!" The arrow tip wavered. Liam had the gun out, covering him, but it was unnecessary.

Christie said thickly, "What the hell are *you* doing here?"

Kate Monaghen smiled sweetly. "I'm protecting our Master from the attentions of ardent young hooligans like you."

"And drop that bow, or I'll blow your arse off," Liam added.

Christie lowered the bow, as though in a dream, not even looking at Liam. "Why are you dressed like that, Katy?"

She minced toward the window, and took the bow from Christie's nerveless fingers.

"Come on in!" Liam urged. "We want to talk to you."

Dazedly, Christie got his other leg over the sill.

Kate said, "I thought it might remind you of old times, Christie."

Christie dragged the heel of his thumb across his forehead, his eyes on Kate's plump bottom as she turned

to prop his bow in a corner. "Jesus!" he muttered. "I've drunk too much."

"Is that where you got the nerve from?" Liam asked.

Kate flashed him a glance. "Cut that out, Liam. And put that gun away. It won't be necessary."

She turned back to Christie. "You're all worked up about Liam's droyt do seenyer, aren't you, lad? Would you sooner he ignored Brege? Especially when every bride in the village since the year dot has been honoured by a summons to the Master's bed."

"If you can call it an honour," Christie mumbled slackly.

"Here, hold on!" Kate's voice rose in protest. "Is that what you thought when you visited me last summer?"

"Ah—no!" Christie showed confusion. "That was different. I mean—I paid you."

"Oh?" Kate registered surprise. "You mean, if Liam gives Brege money, everything will be all right?"

"No, I—I didn't mean that." Christie's eyes rolled wildly. "You're getting me confused, Katy."

She sat down beside him on the window ledge. "Sure, 'tis yerself is responsible, Christie boy." She addressed Liam. "Could you lend us a spare bedroom—and a bottle? The lad's worn out with excitement. He could do with a lie down. I might even keep him company."

Christie looked owlishly at Liam. "Do *you* think it's an honour?"

Liam gazed back levelly, conscious that the day hung in the balance. He said, "I wouldn't do it unless." Suddenly inspired—since he hadn't spoken to Christie's mother, he added, "Just ask your ma what she thinks of it."

Christie's face sobered momentarily. "Can't figure it out. My old lady is all for it. She told me not to do anything daft."

Kate slipped a bare arm round his neck. "And you're not going to, honey, are you? Not when your ma says you mustn't."

Liam pushed the revolver into his belt. "Wait here," he ordered. "I'll see if there's a bed made up." He

didn't dare ring for Michael and have Larry Desmond and Kevin Murphy charging in to the rescue. He jerked a thumb at the delicate inlaid cabinet across the room. "There's a bottle and glasses in there, Katy. Would you offer our guest a drink?"

General Desmond wagged his head in reluctant approbation. "I dunno how you've done it, me lord, but you seem to have pulled it off."

Liam grinned deprecatingly. "Well" he *had* thought of fetching Kate Monaghan in the first place. He said, "It was Kate who did it, really."

Kevin Murphy's glass clinked against the bottle. "And with luck, she'll keep him quiet all night."

Larry Desmond laughed. "It's a change from the way Pat would have worked it. Kind of ironic, if Christie is giving Kate a tumble in one room while Liam—"

"That'll do!" the vet warned. "If Celia were here you wouldn't dare talk like that." He grinned. "Still and all, young Christie won't want to shout too loud in the morning." He raised his glass. "Glory be, Larry—I think we picked a winner!"

Larry Desmond smiled sourly. "Let's wait and see how he copes with the Ice Maiden. I reckon she'll be a harder nut to crack."

Liam closed the bedroom door behind them. The house was quiet. Brege Kennedy still wore her wedding dress. She stood silent in the center of the room, not looking at the turned-down bed, nor at the flowers in the vase on the dresser.

Liam rubbed his hands together nervously. "Would you like a drink, Brege?"

She shot him a pleading glance. "You know I don't touch strong drink, me lord."

He blinked. "It don't have to be spirits. I could wake Michael to make up a cup of tea."

She said, "I think I would like that."

He rang for the servant, then motioned to one of the well-padded armchairs. "Sit down, Brege. Make yourself comfortable."

They sat in silence until Michael appeared. Then in silence again until he reappeared with teapot, milk jug, sugar basin, cups and saucers on a silver salver. When he had gone, Liam cleared his throat, and stammered, "Look Brege—this is no easier for me than it is for you." It stole into his mind, then, that if they didn't do it, no one would be any the wiser. And it would save both of them a deal of grief. And, of course, it would be cheating.

Brege gave him an angry look. "Then why do you insist on having me here?"

He was taken aback. "Hasn't your ma told you?"

She lowered her face, staring at her hands on her lap. "My ma said I ought to come. She thinks it's an honour."

"Is that all she told you?" Liam was beginning to realize just how well the secret of Barley Cross was kept.

She frowned. "What else should she have said? That you'll put her and me dad in jail if I don't do what you want?"

"Ah—no, Brege. Something more serious than that." Liam hesitated. It appeared to be his prerogative as to who got let into the secret. He said, "I'd better tell you, lass. I am the only fertile man in the village. If we don't do it tonight, you'll—you'll never have any children. And if every bride refused to go to bed with me, in fifty years or so, Barley Cross would be a mausoleum."

She was staring wildly at him. "But Liam—it's a sin! We'd be committing adultery!"

He winced. Hadn't he known Saint Brege would come up with something like this? He said desperately, "If you weren't really married, we wouldn't. I don't want to cast doubts on your marriage, but if a man isn't able to consummate it—there's no marriage. Ask Father Con."

She bridled. "I can't talk to Father Con about that kind of thing. Anyway, it's only if a feller knows *beforehand* that he's infertile that the marriage is invalidated."

Liam said gently, "And we don't want to find *that*

out, do we? So if you do what I ask tonight, any child you might have could just as easy be Christie's."

She turned impulsively toward him. Tears were trickling down her cheeks. "Is it the truth you're telling me, Liam McGrath?"

"So help me, God." Liam crossed himself. "It's all a plan the council cooked up, years ago. If your ma and my ma hadn't gone along with it, neither you nor me would be here upsetting each other."

"But why must it be you?" she pleaded. "Why not my Christie?"

He shrugged uncomfortably. "It just so happens that Eileen is having another child. Tommy may have been the O'Meara's, but this second one must be mine. It seems that I, out of all the lads in Barley Cross, have inherited the O'Meara's peculiar genes."

She sniffed. "What does your Eileen think of it?"

"She ain't too happy," he admitted. "But she's agreed to put up with it for the same reasons everybody else does."

Brege dabbed her eyes with a scrap of linen. "Do we do it just the once?"

"So far as I know," he said gently. "If you don't conceive—it's just your bad luck."

She peeped up, hiding her face behind the handkerchief. "I'm shy, Liam. I've never done it before."

He sighed with relief. He was over the hurdle. It was now just a matter of patience and understanding. Barley Cross would never know its luck. He said, gently, "I'll show you how."

She took a quick sip at a cup of cold tea. "Could we have the light out, please . . . ?"

The full council met in Liam's parlour the following day. Brege Kennedy was safely away to the new house which her husband's da had built for her—and where she would find her new husband snoring in the bed. Kate Monaghan was safely back in her cottage down the mill lane, richer by a tablet of toilet soap and a bottle of French perfume. And Liam McGrath was hoping that

his Eileen would not be too curious about the events of the previous night when she returned from her ma's.

Liam straightened his hair, and joined the council.

General Desmond looked up. "Ah, Liam—you've come to report success, I hope?"

Kevin Murphy said drily, "By the smirk on his face, I should imagine that he has."

Liam said, keeping his voice even, "I did what was required."

"Hark now!" The general lifted a finger. "Has he, or hasn't he?"

Dr. Denny Mallon removed an empty pipe from his mouth. "The Master just told us he has, general."

The General wagged a finger. "But not in so many words, Doctor. What if he and our Ice Maiden decided to fool us all, and just pretend they'd done it? Not every marriage in the village is blessed with offspring. We'd never know they'd conned us."

Liam glanced from one to the other. Obviously, they had already been discussing him.

Celia Larkin looked up from her knitting. "Are you accusing our new Master of lying, Larry Desmond?"

The general's jaw dropped. Histrionically, Liam divined.

"I never said so," Larry Desmond protested. "I'd just prefer a more positive assurance than he has given us so far."

The schoolmistress lowered her knitting. "If you're wanting a blow-by-blow description of the exploit, you'll have to manage without my presence."

"Ah no, Celia." Doctor Denny waved his pipe. "That ain't necessary. If Liam says the job's done, then done it is."

"Hold on now!" Kevin Murphy sat up straight. "If the job's been done, then surely Liam can tell us something that would prove he's handing us the truth. Something maybe Denny, here, could confirm. Has the lady a mole on her person, for instance?"

Four pairs of eyes turned on Liam. He shifted his



feet uneasily. "Sure, she insisted on the light going out," he protested.

General Desmond cackled harshly. "Wouldn't you know there'd be a snag? I had a feeling that the Christie victory was just a flash in the pan."

"That's quite enough, Larry Desmond," Celia Larkin snapped. "You agreed to his being made Master. If you trusted him then, why can't you trust him now?"

Why not indeed, Liam agreed silently. But then the general hadn't been faced by a tyro tyrant refusing to wear a uniform until yesterday. And when puppets don't work properly you lose faith in them.

"Enough!" Denny Mallon exploded. "Let the Master be!" He turned to Liam. "Tell them, son!"

Liam made sheep's eyes at the doctor. "But it's *her* secret! Brege will never forgive me if I let it out."

"Tell us what?" demanded the general. "Have you two been cooking something up between you?"

"Tell them!" thundered the doctor. "They'll never be satisfied until they know." He glowered around the room, as if daring anyone to contradict him. "And, remember—anything said at this council meeting is as inviolate as the confessional."

Liam shook his head in disgust. So much for promises made in the dark. Poor Ice Maiden! Her secret divulged to protect the Master's probity.

Reluctantly, he told them. "Brege Kennedy has a deformity she don't like anyone knowing about—except people like Doctor Denny, who *have* to know. Brege isn't cold, nor pious, nor shy. It's just she has knock knees."

# THE LEADING EDGE

*Roland J. Green*

Stephen Donaldson, *The Mirror of Her Dreams; Mor-  
dant's Need*, Part One. New York: Del Rey/Ballantine  
Books, 1986. \$19.95.

Orson Scott Card, *Speaker for the Dead*. New York:  
Tor Books, 1986. \$15.95.

William Gibson, *Count Zero*. New York: Arbor House,  
1986. \$15.95.

Roger MacBride Allen, *Rogue Powers*. New York:  
Baen Books, 1986. \$3.50 paperback.

Lois McMaster Bujold, *The Warrior's Apprentice* and  
*Ethan of Athos*. Both New York: Baen Books, 1986.  
\$2.95 paperback.

Lee Killough, *Spider Play*. New York: Questar/Warner  
Books, 1986. \$3.50 paperback.

Martin Caidin, *Zoboa*. New York: Baen Books, 1986.  
\$3.50 paperback.

Suzette Hadin Elgin, *Yonder Comes the Other End  
of Time*. New York: DAW Books, 1986. \$2.95 paperback.

Kevin Randle and Robert Cornett, *Seeds of War*.  
New York: Ace Books, 1986. \$2.95 paperback.

Arthur C. Clarke, *July 20, 2019*. New York: Omni/  
Macmillan, 1986. \$24.95.

In six volumes of the adventures of Thomas Cove-

nant, Stephen Donaldson gave the impression of having two firm goals. One was to wear out his thesaurus. The other was to be sure that none of his characters could ever be mistaken for John Wayne.

He succeeded admirably in both. He also succeeded in writing an impressive fantasy saga, one of the most popular since *LORD OF THE RINGS*. Many readers will still find his new saga, *MORDANT'S NEED*, nearly as impressive and a great deal more readable.

In the first volume, *THE MIRROR OF HER DREAMS*, Terisa Morgan, rejected daughter of a millionaire, is magically translated from her mirror-lined New York condo to the medieval land of Mordant. In Mordant, mirrors are used only for a form of magic called Imagery, by which objects and people can be transported from one place to another.

Mordant faces invasion by two hostile neighbors, as well as the senility of its ruler, King Joyse, and intrigues among its Imagers. Terisa *may* be the champion summoned to save Mordant. From being perpetually on the sidelines, this naive young woman is dragged quickly (not to mention kicking and screaming) into the center of the action.

She faces a host of life-and-death questions. Whom should she trust—the attractive Master Eremis (who keeps trying to seduce her), or the honest but inept apprentice, Apt Gerarden. How senile is King Joyse? Will she escape Castellan Lebbick's suspicions that she is an enemy spy?

To most of these perils-of-Pauline questions, the book offers partial answers or none at all. It ends in an annoying cliffhanger, like rather too many books in multi-volume works these days. Quite possibly, all the other places for breaking Donaldson's manuscript into units of publishable size would have been worse, but the annoyance remains.

The book does conclusively demonstrate that Donaldson's maturing as a writer. In place of a style too often ponderous and a heavy emphasis on emotions, there is

grace, wit, a sense of proportion, and a new level of concern for his readers.

The latest books by Orson Scott Card and William Gibson also suffer somewhat from being the middle of trilogies. (At least the Gibson is known to be so, and the Card reads remarkably like one.) They are still fine efforts, if not quite up to the level of their award-winning predecessors.

Card's *SPEAKER FOR THE DEAD* takes up the tale of Andrew/Ender Wiggins three thousand years after the near-extinction of the Buggers in *ENDER'S GAME* (Tor). Thanks to the relativistic effects of star travel, Andrew (who hides his identity as Ender the Xenocide) is only in his late thirties. He is a Speaker for the Dead, a traveling deliverer of memorial speeches intended to raise the consciousness of the listeners.

Now he is called to the planet Lusitania, where a human colony of Portuguese Catholics and a pre-industrial sapient race known as the Piggies have been trying to coexist peacefully. He is to Speak the Death of a xenologist killed by the Piggies—like his father before him.

This crisis pulls Andrew into a desperate struggle to find the reason for the xenologists' deaths. If he fails, either the human colony on Lusitania will be exiled, or there will be another xenocidal war. By discovering the secret of the Piggies' life cycle, Andrew succeeds well enough that at the end of the book, he is releasing the last Hive Queen of the Buggers, to lay her eggs and bring her race back to life again . . .

The book lacks a hard core as powerful as Ender's transformation from rejected child to superwriter in *GAME*. In fact, it rambles a trifle, and Card's poetic language occasionally calls attention to itself. Its great strengths are the characterization and philosophical concerns, which still raise it above much of the competition.

Gibson's *COUNT ZERO* opens seven years after the end of *NEUROMANCER*, in which the global com-

puter net, the Cyberspace Matrix, became sapient. It shows three manifestations of that sapience.

A low-grade "matrix cowboy" (the Count Zero of the title) tries a routine piece of computer espionage, nearly has his brain destroyed, and finds himself aided by voodoo priests and pursued by corporate mercenaries.

Another corporate mercenary tries to arrange the flight of a brilliant scientist from one corporation to another. He barely escapes with his life and the scientist's daughter, whose brain has been modified in some quite inexplicable ways.

Finally, a young woman art dealer is sent by a mad millionaire to track down the origins of some wholly unconventional artwork.

Gibson doesn't fully integrate the three subplots until too close to the end; this is really three novellas sharing the same cover and title. He does practically everything else nearly as well as he did in *NEUROMANCER*, including writing superb action scenes. Clearly, Gibson can write pretty much anything he chooses—which means we can look forward to his being around long after "cyberpunk" is no longer a recognizable category.

On Baen repeaters:

"Baen Repeater. A .52 calibre repeating rifle, using a tubular magazine, developed by Elihu K. Baen of Westhollow, Connecticut, in 1862. First used by Buford's Brigade at Gettysburg, 1863. Ballistically superior to the Henry repeater but harder to maintain. During the Second North-South War (1878–1882), equipped second-line U.S.A. cavalry units; captured specimens also saw service with Confederate cavalry, subject to ammunition availability . . ."

Oops. That's another time-line—and there will be more said on the subject of alternate time-lines, one of the fastest growing sub-genres, but not in this column.

In our time-line, a Baen Repeater is a Baen Books author who, having written one good book, goes out

and does it again. This month: Roger MacBride Allen and Lois McMaster Bujold.

As we all hoped, Allen's **ROGUE POWERS** deals with the League's victory over the fascist Guardians. Mac and Joslyn Larson appear again, fighting bureaucratic or alcoholic superiors as well as the Guardians' fleet. However, the real protagonist is Lucille Calder. One of the Survey Service cadets captured by the Guardians in **TORCH OF HONOR**, she became the key person in dealing with the Z'ensam, a centauroid race whose science is entirely biological. This gives them, among other things, a terrifying and nearly unstoppable arsenal of biological weapons. Then a faction among them decides to ally itself with the Guardians as a first step toward annihilating all sapient life in the Galaxy . . .

**POWERS** is a little less coherent than **TORCH**, except toward the end. Otherwise, it's solid, intelligent entertainment, making one again wish to hear more from Allen.

Lois Bujold's **SHARDS OF HONOR** started her off with a bang. Her two subsequent books, **THE WARRIOR'S APPRENTICE** and **ETHAN OF ATHOS**, are laid in the same universe and reach the same high level.

**APPRENTICE** is the tale of Miles Naismith, son of Aral Vorkosigan, and Cordelia Naismith. At seventeen he is dwarfed, deformed, and fragile, the result of prenatal exposure to poison gas during an assassination attempt on his parents. This is no small handicap on Barrayar, where military service is the duty of the aristocracy, the Vors, and physical perfection and good looks are the ideal.

Somehow, Miles manages to stumble into a progressively more and more successful military career—so successful that his father's enemies narrowly miss convicting him of treason and rebellion against the Emperor. No summary could do justice to the shifts and expedients Miles uses, but one of his officers sums it up fairly well:

"Mayhew snorted. 'Your forward momentum is going to lead all your followers over a cliff someday.' He paused, beginning to grin. 'On the way down, you'll convince 'em all they can fly.' He stuck his fists in his armpits and waggled his elbows. 'Lead on, my lord. I'm flapping as hard as I can.'"

We also see a good deal more of Bujold's developing universe and Barrayaran society, and a powerful subplot deals with the fate of Sergeant Bothari. At the end, Miles's pickup force, the Dendari Mercenaries, are still in existence as Imperial troops, with the promise of seeing more of them.

This promise is partly fulfilled in *ETHAN OF ATHOS*, although except for one of their intelligence officers, they are offstage throughout the book. The protagonist is Ethan Urquhart, a homosexual obstetrician—and if you think this takes the all-time award for Most Unlikely Adventure SF Hero—well, you're right, but Bujold brings it off.

Obstetricians are vitally important on the planet Athos. Settled two centuries before by a misogynistic religious sect, it has reproduced its all-male population with artificial wombs and ovarian cultures. Now the cultures are deteriorating, the planet's future is threatened, and Dr. Urquhart is sent on a desperate mission to find some new cultures.

He finds them, all right. He also finds himself being chased all over a gigantic orbiting colony by assorted sets of bad guys. The worst is a team of soldiers in search of an escaped, genetically tailored telepath. Ethan's only ally is Commander Eli Quinn, of the Dendari Mercenaries.

Although Quinn is female, Bujold resists the temptation to have her "cure" Urquhart's homosexuality. In fact, she resists every temptation to exploitation, bad taste, or even clumsiness in her handling of the homosexual themes in the book.

We also see yet another slice of Bujold's universe. It begins to look as if she has built enough world for fifty

books. Let's hope she has not only world enough but time to write them.

The "transplant" has an unjustifiably bad name in some SF circles. If there are going to be romances or mysteries in future societies, why aren't they a legitimate topic for SF?

Lee Killough's *SPIDER PLAY* is her second novel about two police detectives in 21st-century Topeka—blonde Janna Brill and her zany black partner Mama Maxwell. Like its predecessor, the *DOPPELGANG-ER GAMBIT* (Del Ray/Ballantine), it is basically a straight police procedural set in the future.

A stolen hearse turns out to contain a badly mutilated body. Identifying the body leads Janna and Mama into the Topeka underworld, then to an orbiting industrial space station. Industrial espionage (centered around the "Spider" of the title, a revolutionary zero-G construction device) has led to murder, and Janna and Mama want to find the murderer.

Killough satisfies the requirements of both the police procedural and the SF novel, with a particularly good eye for revealing little details about her future world. She also makes it pretty clear that we haven't seen the last of Janna and Mama, nor have they seen the last of each other.

Martin Caidin has been accused of doing something even worse than writing "transplants." He writes "what really isn't true SF at all"—true SF being whatever the critic decided was such at the age of fourteen.

In fact, I suspect that Caidin wouldn't argue the point—if he even bothered to answer such cases of mental constipation in the first place. Well before he wrote his first space-oriented novel, the classic *MAROONED*, he was one of the country's best and most prolific aviation writers. (I still recall fondly his *EVERYTHING BUT THE FLAK*, the slapstick tale of ferrying three decrepit B-17's from Arizona to England



for the filming of *The War Lover*.) He has written about space as an extension of flying, neither more nor less.

In ZOBOA, the only space element is a space shuttle, whose launch is the target for the four atomic bombs stolen by Arab terrorists, and of frantic efforts by U.S., Russian, and private agencies to defend it. Otherwise, it's a hymn of praise to the collectors and pilots of "warbirds"—antique military aircraft—some of them veterans, some just devoted hobbyists. Caidin knows and loves warbirds, knows and loves the people who fly them, and from that knowledge and love builds an absorbing story, full throttle ahead and damn the labels!

Over a fifteen-year period, Suzette Hadin Elgin has produced a quantitatively modest and qualitatively superior body of fiction. In YONDER COMES THE OTHER END OF TIME, she brings together her two best-known protagonists—Coyote Jones and Responsible of Brightwater.

Jones, the projective telepath secret agent for the Tri-Galactic Federation, lands on the planet Ozark. Ozark was settled in the 21st century by refugees from that area of the United States, using a magic they developed from certain linguistic techniques. That magic has given them a tolerably civilized existence, and under the leadership of fifteen-year-old Responsible of Brightwater, it even defeated an alien invasion.

Unfortunately, the magic also makes Ozark invisible to all known methods of detection, and therefore a mystery that has to be investigated. Coyote Jones is the lucky man sent to investigate. He runs head-on into Responsible, nine years older and even harder to push around. He runs head-on into the Ozarkers' magic, which can defeat even his projective telepathy. Finally, he has to retreat in disorder from the flat refusal of the Ozarkers to have anything to do with the Tri-Galactic Federation!

Elgin does not ask us to believe in more than one impossible thing—the Ozarkers' magic. Beyond that,

the story is brisk, eminently literate, and filled with Elgin's delightful dry wit.

Kevin Randle and Robert Cornett are a trifle short on wit in *SEEDS OF WAR*, but their subject matter doesn't really lend itself to humor. There's something absurd, maybe even ludicrous, in an army of teenagers with a cadre of professional soldiers crossing the light-years to take somebody's home planet away from them. There's not much occasion for wit.

The book does have everything else that one expects in good military SF. Randle and Cornett, both Vietnam veterans, are definitely heavy on the weaponry and tactics, making for lots of good, fast-paced, gritty action scenes. They haven't scanted the characterization, however; Lara Masterston is one of the better additions to the ranks of female soldiers in some time. They get around the logistical implausibility of this kind of interstellar campaign by giving the aliens a peculiar, biologically dictated social system, but that doesn't exceed their quota of impossible things.

A thoroughly respectable addition to military SF.

Arthur C. Clarke puts on his futurist's hat in his *JULY 20, 2019*. It opens with a "Letter from Clavius," supposedly written by Clarke himself at the age of 102, in yet another attempt at retirement, this one on the moon. Beyond that, large parts of it read like a further updating of *PROFILES OF THE FUTURE*, supplemented by an impressive array of high-tech graphics and illustrations.

In fact, dismissing the book as a mere recycling of previous material would be doing it an injustice. Clarke deals with a wide range of social institutions, including birth, marriage, sex, death, and the effect of the "smart" house on domestic life. The beginning point of each discussion is still technology, but he no longer stops there.

The book also has Clarke's customary wit, optimism, and resolute faith that technology can be made to serve

human rationality and bring us all to a better world. Considering how many people lack that faith, and how much harm they are doing, one may thank Higher Authorities that Clarke is still alive and writing, and hope that his "Letter from Clavius" is a prophecy. We may need him around for that much longer!



*Introduction to*  
**THE IRVHANK EFFECT**

*History is replete with weapons that on first examination were thought too terrible to ever be used. Ultimate weapons that weren't include Greek fire, crossbows, and machine guns. Is there, even conceivably, a weapon too terrible to use on other human beings—at least if they are in a position to return your attentions in kind?*

*Hint: Europe is in the midst of the longest outbreak of peace it has ever known.*

# THE IRVHANK EFFECT

*Harry Turtledove*

The Nevada desert looks like a proving-ground for hell. That is not the reason the government tests its atomic weapons there, but it does give the more thoughtful technicians pause.

As one of the devices—a much more sanitary and less hair-raising word than “bomb”—was making its long journey underground, an engineer in the blockhouse said to the man at his elbow, “Just once, I wish the goddamn thing wouldn’t go off.”

“Don’t we all, Dave, don’t we all,” his companion said. “However, things being as they are—”

“I know, Felipe,” Dave sighed. The device was in place now, a good many thousand feet below the desert. The countdown proceeded smoothly. No reason why it shouldn’t; after hundreds of tests over four decades, a routine had long since grown up.

Dave waited for zero. The bomb down there was a pee-wee, forty kilotons nominal yield, but it could still make the ground rock ‘n’ roll. Hell, they’d feel it in Vegas, fifty miles southeast down US 95. He was a lot closer than fifty miles, worse luck.

Zero came and went. The desert remained unshaken; the instruments in front of Dave did not go wild. The voice of the principal investigator boomed over the

intercom: "Gentlemen, we appear to have a glitch somewhere. We're trying to track it down now. Please stay at your stations."

"Willpower, that's what it is," Dave said, flexing a stringy bicep.

"Bullshit, that's what it is," Felipe snorted, and made as if to hit him with a clipboard. His friend flinched.

US 95 skirts the edge of Nellis Air Force Range and Nuclear Testing Site. The four-wheel-drive Toyota pickup had left the highway about two thirds of the way from Beatty down to Lathrop Wells. No one paid any particular attention to it; there were always a lot of off-road vehicles chewing up the Amargosa Desert.

The pickup stopped well outside the edge of the air force range. MP's did a lot of patrolling on test days. The two men in the truck had a fair amount of electronic junk and a portable generator bolted to the cargo bed. The last thing they wanted was to be taken for a couple of Russian spies.

Irv Farmer got out on the passenger side. He was in his late twenties, slim (well, skinny, actually), sandy-haired, and too pale to be wearing only a T-shirt and shorts in the fierce desert sun. The thin weave of his cap, which proclaimed his allegiance to the Philadelphia Phillies, did not give his balding scalp nearly enough protection.

"Christ, I'm gonna look like a lobster tomorrow," he said. He could not even tell how much he was sweating. The hot, parched air dried the moisture on his skin as fast as it appeared.

Hank Jeter let out a rich, booming laugh. "What do you know? Finally I'm somewhere where being black does me some good." *Los Angeles Raiders*, his cap said. He looked like a defensive lineman; each of his thighs was nearly as big around as Farmer's waist. In spite of his formidable appearance, he was a talented physicist. So, for that matter, was Irv Farmer.

Irv persuaded the generator to flatulent life. The two men worked together to hook their gadgetry to it. Anx-

iously checking one meter after another, Jeter asked, "What time is that sucker supposed to go off, man?"

"Let me check." Irv ambled back to the cab of the truck, got out a copy of yesterday afternoon's *Las Vegas Sun*. The story he was looking for was on page five. " 'Local residents are advised not to worry if they feel an earthquake tomorrow,' " he read. "The NRC is conducting another of a series of low-yield nuclear tests, with detonation scheduled for 10:52 A.M.' "

Jeter pulled out his pocket watch, glanced at it. "We got set up just in time. Only ten minutes to kill. How about a beer?"

"Best idea I've heard all day." There was a cooler in the truckbed, too. Farmer pressed an icy can of Coors to his forehead before he opened it. He drank the Colorado Kool-aid down in four long, blissful gulps, but Hank Jeter still finished ahead of him.

Ten fifty-two passed. So did eleven o'clock, and ten after, quite without an earthquake. The big black man and the little white man solemnly shook hands. "Yes, ladies and gentlemen, boys and girls, I would say we have something here," Jeter said.

"I would say we do." Farmer reached in and turned off the generator. The ground under his Nikes gave a lurch. He had to grab for the tailgate to keep from falling into a cactus. His eyes glowed. "Yes, I'd say we do."

Like a lot of discoveries, this one had been more accident than design. Several things went into it: the fact that, by some accident of engineering, the lab apparatus had a backup and the overhead lighting didn't; the fact that Hank Jeter's great-grandfather had worked as a railroad chief porter during the 1920's; and the fact that Hank was seeing what time it was at the exact moment when a drunk slammed into the power pole out on Rhawn Street.

The lab was in an interior room, with no windows, and the sudden darkness was stygian. People swore in disgust. Somebody tripped over a stool, which fell with



a crash. "Where's the flashlight, goddamit?" somebody else said.

Hank didn't need it; not, at least, to look at his watch. That watch had been in his family since his great-grandfather's day. As a matter of fact, it was a conductor's watch, but great-grandpa had bought it all the same, just as soon as he could afford it. He loved it, and why not? It had been keeping good time for more than sixty years now, a big, old-fashioned stemwinder with a long, thick gold chain, perfect for wearing in a vest pocket. It had a radium dial that glowed in the dark.

Except it wasn't glowing now. Hank held it so close to his face that it almost bumped his nose, squinted until his eyes crossed. Nothing.

Just then, someone found the flashlight. It was pointed straight at Hank's face when it got turned on. In total blackness, it was like a magnesium flare exploding. Hank yelped and nearly dropped his watch.

"Everybody out to the parking lot," the fellow with the light said. He had a loud, officious voice, and herded his colleagues along like sheep.

Sirens were baying outside, what with the police, paramedics, fire engine, and electrician all descending on the drunk and the pole he'd knocked over. It was also, as Hank discovered when he got into the light, a quarter past four. Plainly, not much more was going to get done today.

The section chief saw that too. He sent a couple of people back into the lab to turn off as much equipment as they safely could, and let everyone else go home early.

There was a scattering of muffled cheers, and some not so muffled. Hank turned to Irv Farmer and said, "How about a drink?"

"Motion seconded and passed by acclamation. Where to?"

Hank looked at him in honest surprise. "The Lair; where else?"

The bar was a couple of miles from the lab. The

power was on there, but it was almost as dark inside as it had been when the lights went out at work. Jeter ordered bourbon. Farmer got a bottle of Anchor Porter. He had acquired a taste for the stuff in his undergrad days at Berkeley; the Lair was one of the few bars on the East Coast that stocked it. Thick and dark, dark brown, it was the pumpnickel of beers. He sipped at it; it was too strong-tasting to pour down.

"Another day shot to hell," Hank said, lifting his glass.

"You know it." Irv licked creamy foam off his upper lip. "The surge when the auxiliary generator kicked in cost me half my data, I'll bet."

Jeter put his head in his huge hands. "Oh, God, I forgot all about that. Me too."

One drink became several. After a while, Irv said, "What time has it gotten to be?"

"Why are you asking me? You've got a watch on your wrist," Jeter retorted in mock anger. "Just because I'm black, you make me do all the work."

"Oh, bull. If I didn't ask you to haul out that brass turnip of yours, you'd sulk for a week."

"A likely story." Chuckling, Hank looked at his great-grandfather's watch. "It's twenty to seven." He frowned. "That's funny."

"No it isn't. I just remembered I'm supposed to be in Southbridge at seven, and I'm never gonna make it."

"No. Look at the dial."

"I've seen it a million times, thanks."

"It's glowing," Jeter said.

"Well, I should hope so. It's a wonder you don't futz up half the experiments in the lab with the radioactivity in that damn thing."

"You have no respect for an heirloom, my man. The point is, though, when the electricity went out this afternoon, I was looking right at it and there was nothing to see, just black."

"Probably you were looking at the back side and didn't realize it in the dark," Irv suggested.

"Hey, no, man, I'm serious," Jeter said. "I had it out

before the power blew. I can't remember the last time I looked at it in the dark; I just figured the radium paint had worn out or something. Now I don't know what to think."

Irv Farmer stared owlishly at his friend. He had drunk just enough to take him seriously; a little more and he wouldn't have cared one way or the other, a little less and he would have rationalized everything away. Instead, he said, "All right, I give up. What happened?"

Hank shrugged. "Just one of those things, I guess." Being almost twice Farmer's size, he hadn't been hit as hard by his shots of Hiram Walker's. As long as everything seemed back to normal, he was happy enough—relieved might be a better word.

Irv finished his porter. "Let's go back and see if we can duplicate it," he said suddenly.

It was Jeter's turn to gape. "Probably nothing there to duplicate."

"Then what have we lost? A little time."

"What about Southbridge?"

"Oh, the hell with Southbridge. She's starting to think she owns me. Come on; are you game?"

"That's what they asked the hunter in the old joke, and when he said yes they shot him. But I'll come along; I've got nothin' else shakin' tonight."

As they drove up, they saw the lights were back on. "Can't keep you fellers away from it, can they?" cackled the security guard. The old codger didn't bother looking at their security badges; he'd been seeing them come and go for years.

"This isn't going to work," Hank said when they got to the laboratory. "How can we tell what was on and what was off when the power pole got hit?"

Alcoholic confidence still buoyed Irv Farmer. He went from bench to bench and desk to desk, checking diaries. Once he picked a lock with a paper clip, something he never would—or could—have done cold sober. He made a second circuit round the lab, turning

on instruments and setting them to the same configuration they had had during the afternoon.

At last he turned to Jeter. "All right, where were you?"

"Right about here," Hank said, taking his spot. "Look, man, let's just pack it in, shall we? This is all more hassle than it's worth."

Irv wasn't listening to him. "Get out your watch," he said, and turned off the lights. Hank didn't say anything, so after a minute or so Farmer called, "Well, what do you see?"

"Come look for yourself."

Irv did, moving carefully in the dark. Hank held the watch out to him. The hands and the small painted spots that marked the hours were dark. "Well, I will be damned," Irv said. His friend was whistling tunelessly between his teeth.

"Where are you going?" Hank asked.

"To turn the lights back on. I've got an idea." Farmer rummaged around until he found a Geiger counter. He held the Geiger tube up to the watch. The lazy clicking of background radiation, present everywhere, did not change. Irv and Hank looked at each other.

Irv started turning off pieces of lab equipment. The Geiger counter immediately began to chatter.

"Do you know what we've got here if we can find out what makes this tick?" Farmer said softly, oblivious to any thought of wordplay. "We've got a Nobel prize right in our laps, that's what."

Hank Jeter regarded him most soberly. "It may not be anything nearly as trivial as that," he said.

After they'd found the effect, they had to figure out how it worked and what to do with it. By unspoken common consent, neither of them mentioned it to the people they worked with, and they made sure they didn't leave any notes lying around the lab. They did put in a lot of overtime they didn't get paid for, often in the wee small hours.

For one thing, they had no idea *why* the resultant of

all the forces in the gadgetry in the lab on that particular day produced a field that damped radioactivity. That bothered Hank. He wanted to know.

Irv was not as fussy. "Look," he said at the Lair one evening, "right now I don't much care about why. All I want to know is how I can use it. People were making gunpowder hundreds of years before they knew thing one about oxidation or any of that." His argument carried the day.

Lack of understanding, though, was not the chief reason they kept things to themselves. The more they played with what they had begun to call the Irvhank Effect, the more they realized just how big a thing they had stumbled across. That first field of theirs was a very strong, very tight one: it damped all radioactivity above background level, but it only had an effective radius of about ten meters.

"We could clean up Three Mile Island with this," Irv said. Hank only grunted. He had bigger things in mind.

Their early tries at altering the field only succeeded in eliminating it altogether. It was Irv's turn to think more progress impossible, Hank Jeter's to keep pushing. After a good deal of frustration, they finally found the components of the system they had to modify to change the strength of the Irvhank Effect. They also found that each weakening of the field increased the range over which its effect spread.

It took many months of work before they got the kind of field Hank had conceived of the moment he heard that quiet Geiger counter: one weak enough to allow the barest chain reaction, the level found in an atomic pile, but strong enough to prevent the catastrophic fission of nuclear weapons.

That was the one that sent the two of them into the Nevada desert, to see if their circuits did what they were supposed to. Actually, the trip was conservative; if their haywire calculations were right, at that level the field should cover most of the United States. When they found out that the device worked, they hooked it up to wall current and let it run night and day.

"Let the Russians roar," Hank declared. "Those sons of bitches aren't going to blow us all away now, no matter how much they want to. Do you know what we've done, Irv? We've declared peace against the whole world, and we've won."

As things worked out, the Russians weren't doing much roaring of late. They were grumbling, mostly among themselves. It was Irv who noticed the name of a prominent Soviet general in the "Milestones" column of *Time*.

"'Retired,'" he read. "'Marshal Pavel Serafimov, 62. Western intelligence sources believe that Serafimov, a leading expert in nuclear weaponry, was forced into early retirement because of the unexpected difficulties the Red Army is having with the warhead of the new SS-26 ICBM.'"

Hank's smile was blissful. "We aren't just covering the USA, then. I sort of suspected you were too cautious with your numbers, Irv. If the Russians' bombs won't go off even at home, we've got the whole planet blanketed. Now we don't have to worry about a nut in the White House or the Department of Defense, either. To say nothing of the Israelis, the South Africans, the Pakistanis, the Argentines—how long do you want me to go on?"

"No need, no need," Irv said. "I think it's about time we looked into publishing."

You have to understand that I've pieced all this together. Obviously, I wasn't there when the two of them discovered the Irvhank Effect. There are still lots of things I don't know about it. And, as I've said, they were careful about covering up what they were doing, for amateurs anyway.

I tell you frankly: a lot of people were tearing their hair, trying to figure out why none of the bomb tests would work. After the first couple of failures, we were also going out of our minds trying to keep the Russians—to say nothing of Congress—from learning things were on the fritz.

Of course, it turned out the Russians had troubles of their own, but we didn't know that then. You can imagine how relieved we were when we found out. At least they weren't responsible for screwing us up.

But who was?

It took a lot of time—people time and computer time—before a possible answer emerged. Again, I don't have the details, just what I got in my briefing. Apparently, somebody was smart enough, or desperate enough, to ask for a computer search of any and all anomalies having anything to do with radiation, and then to stick pins in a map to see if there was a pattern. Sure enough, there was.

Some of the items had made the newspapers, others hadn't. The day when all the nuclear plants east of the Mississippi hiccuped for six seconds was one of the latter. With everyone loving nuclear power so much these days, most of the plant directors had covered up as best they could, especially since they didn't know what had gone wrong either. But those people are amateurs too.

Other things were less spectacular—high-energy physics experiments gone awry, disappointingly ineffective cancer treatments, and so on. Those were also more localized. They gave us an idea of where the center of the problem-circle was. We were able to start putting together a list of names.

Two people on the list, it turned out, had been vacationing in Las Vegas on the morning when a bomb test was inexplicably late. That was enough to be worth looking into, anyhow, and that was when I got my orders.

As it happened, I went to Irv Farmer's condo first, while he was at work. Jackpot the first time, too; I found the half-written paper on the Irvhank Effect in the typewriter, with all the notes beside it. I skimmed through them. The machine itself, I learned, was at Hank Jeter's apartment, under the bed.

Amateurs.

I took all the documents and stuffed them into the

repairman's bag I carried in case anyone got curious about what I was doing wandering the halls. Then I went out and goofed around for several hours. I knew just what Irv Farmer would do when he got home and found his place burgled—he'd rush over and tell Hank. That was fine. I needed to talk with both of them.

My timing was right. I heard two voices when I paused to listen outside the door. I went on in. Apartment-house locks aren't made to keep out the likes of me.

"Don't do anything stupid," I advised the two of them as I shut the door behind me. I was mostly talking to Jeter; nobody'd told me what a mountain of beef he was. "This in my hands is a silenced UZI machine-pistol with a forty-round box. A burst will make a noise like Donald Duck sneezing and leave you both hamburger."

I had to give Irv Farmer credit. He went white as a sheet, but his voice came out steady: "I thought you weren't supposed to fire bursts through a silencer."

"For emergency use only," I agreed, "but your friend there on the sofa is big enough to qualify."

"If you want money, my cash is in the silverware drawer in the kitchen," Jeter said. He didn't sound as though he believed it himself; even in the US of A, robbers don't pack UZI's with silencers. When I just stood there, he sagged a little. "Who are you with?"

"It doesn't matter," I said. "Believe it or not, at the moment all I intend to do is have a chat."

Hank was still a bit stunned; Irv was quicker on the uptake. "If you're the one who was at my place"—he paused, and I nodded—"then I think we know what you want to, ah, chat about."

I nodded again. "No doubt. Tell me, can your gadget, say, protect the United States from nuclear attack but leave the Soviet Union open?"

"No way," Farmer said. "The whole planet gets protected at that setting. It's in the nature of the field."

I would have believed him even if glancing over his notes hadn't led me to the same conclusion; you could



read his sincerity in his face. "So what exactly is it you're accomplishing, then?"

That roused Hank Jeter. "Putting an end to the possibility of nuclear war," he growled. The look he sent my way said that even somebody like me should be able to figure that one out for himself.

I shrugged. "And so?"

"What do you mean, 'And so?' " he said. "And so peace, of course."

"We're at peace now," I reminded him. "We have been since 1945, more or less."

"A peace based on terror," he said scornfully. "That kind of peace never lasts, and the kind of war we can fight with today's weapons is too terrible to imagine."

"There I agree with you," I said, and saw I'd surprised him. I went on, "But what makes you think that turning off all the nuclear weapons is going to do anything to promote peace?"

He looked at me as if he thought I was crazy. He probably did. "We won't be able to blow ourselves away, that's what."

"With all the germs and gases stockpiled, I wouldn't even bet on that," I said. "Let it go, though. Just tell me this. Suppose you're the President of the Soviet Union. And suddenly your missiles and the Americans' missiles are only so many big Roman candles. You take a look toward western Europe. You've got about a 3-1 edge in tanks, 2-1 in planes, maybe 3-2 in ground troops. Nothing much is going to happen to your country if you move. So what do you do?"

"Nothing much is going to happen?" Irv echoed. "You're still going to get the hell bombed out of you, and invaded if you start losing."

"By Russian standards, that's nothing much," I said. "And the last people who made a go of invading Russia were the Mongols. Hardly anybody on this side of the Atlantic remembers that the Russians did the dirty work in World War II after the Germans jumped 'em. They took eleven, maybe thirteen million armed forces

deaths, plus another seven million or so civilians who happened to be in the wrong place at the wrong time."

Irv and Hank were both staring at me now. They grew up with Vietnam: fifty-odd thousand dead, spread over a dozen years. They were too young to remember how easy it was to fight a really *big* conventional war.

I said so, adding, "Why do you think we haven't fought the third World War yet? It could have started any time: over Korea, or Hungary in '56, or the Berlin Wall, or Czechoslovakia in 1968, or Poland in '81, or Vietnam, or the Middle East half a dozen different times. For that matter, why doesn't China try to take most of Siberia back from the Russians? Their maps claim it, you know." They plainly didn't.

I said, "Aside from anything else, there's another reason to keep away from World War III—we'd probably lose. The Russians outweigh us by too much in conventional weapons, and the geography favors them."

"China," Farmer said. He'd been paying attention, some.

"Maybe, just maybe," I admitted. "But that's a deal with the devil, too, the same as the one we had with Stalin to beat Hitler. We'd probably just be setting up the next round."

"You have one sick view of human nature, man," Hank Jeter said.

I shrugged. "I suppose so, but I'm afraid I've got an awful lot of history to back it up. Seems to me the only thing that's kept such peace as we've got is the terror you were sneering at. What else is strong enough? And what's going to happen when people find out there's nothing to be afraid of any more?"

If I sound like I was pleading with them, I was. I'd never gotten a set of orders I liked less, and I was looking for some excuse to break them. But try as I might, I couldn't find one. Maybe Irv and Hank could. After all, they were bright enough to have created this flap in the first place.

No luck, dammit. They hadn't thought out the consequences any further than keeping the bombs from fall-

ing, and that wasn't far enough. Any minute now, somebody was likely to realize that things weren't going bang because they couldn't go bang. Then it would be time to hold onto your hat, assuming you still had a head to wear it on.

Donald Duck sneezed. I still had half a clip left when I went into the bedroom. I unplugged the cord that snaked under the bed. The world didn't feel a bit different, of course, but it should have. I used the cord to haul out the gear that generated the Irvhank Effect, and I put the rest of the clip into it. Pieces flew every which way.

I had to move fast after that. The more you fire a silenced weapon, the less effective the silencer gets—Irv had been right about that. Hank's notes, thank God, were easy to find. I tossed them onto the floor, set Irv's beside them. Then I poured gasoline over them, tossed a match, and ran like hell.

I'm glad they managed to hold the fire to three floors of the building. It gave the papers a week's worth of stories, but none of them had anything to do with me, so that was all right, too.

Everyone at work was relieved when I reported success, and when the obvious experiment confirmed it. We've been dealing with the mess we know for a long time now; I expect we'll muddle on a while longer. The Irvhank Effect—I hope!—was one of those freak discoveries that won't be stumbled on again for hundreds of years. By then, we may know how to handle it.

For that matter, nobody asked me a whole lot of questions about how the Effect worked. It's as if we're all trying to pretend the whole thing never happened. That's good enough for me. I'm the only one who knows so much as its name now and I don't know much more than that. I shouldn't even be writing this much down.

More later. Somebody's at the d. . . .



*Introduction to*  
**POPPA WAS A CATCHER**

*Back in the late-seventies a concerted effort on the part of America's space community dissuaded our politicians from ratifying a "U.N. Treaty Governing the Moon and Other Celestial Objects." In essence, the treaty would have relegated the Solar System to the status of a U.N. Protectorate, and placed all off-Earth personnel and facilities under the legal authority of the U.N., said authority being exercised by a special Commission. In this story the Lunar Treaty became law. . . .*

*Actually, such an outcome is still all too likely; the damned thing is still floating around awaiting some more accommodating American administration. (No, not Reagan; it was Carter who had the attack of brains to the head.)*

# POPPA WAS A CATCHER

*Steven Gould*

Poppa was a catcher on the Company team,  
Slowing down the rocks as they came down the beam,  
Sometimes they were low ones,  
Sometimes they were high.  
Sixteen tons of ore in the blink of an eye.

Momma she pushed veggies in the Company tanks,  
Kept from going crazy by the Company trunks.  
Bees can't stand the spinning,  
Bees can't hardly stand,  
Momma trucks down aisles pollinating by hand.

One day Poppa slipped up as it buzzed across the plate,  
Thirty tons of ore like the black hand of fate.  
Burn you mother thruster,  
Thruster she won't burn.  
Poppa's ship is making like a funeral urn.

Momma got called into the Supervisor's den,  
Told the fate of Poppa by the Company men.  
Damn your stupid husband!  
Don't give us any lip.  
Can't you see how much it costs to replace that ship?

Momma left the bossman in a rush of tears,  
Couldn't take the sight of those Company leers.  
Heaven help you Poppa,  
You've gone away from me.  
Batted like a homerun for the Company.

She took the elevator all the way to the rim,  
Watching stars go by with a strange little grin.  
Opened up the airlock,  
Shook away the tears,  
Her body will hit Saturn in a couple of years.

From *The Ballad of Baby Boo*  
Copywrite, 2053, The Delta Vees

*The visitor did a number like Rockaby Baby after the bough breaks, falling freely, gracefully north of the plane of the ecliptic, three A.U. from the sun. As it fell it made pretty splashes in the sky, clouds of vaporized metal sprayed behind it to make long, brightly glowing trails. The Hadley-Appennine Observatory on Earth's moon saw them first, followed by the facility at New Eden in Lagrangian Point Five.*

*The clouds came in patterns broken by four-hour intervals. The first group was a single stroke of a cosmic brush. The second, oddly enough, was two dashes of luminescent cloud. The third group had three, and the fourth, to nobody's great surprise, had four.*

*Spectrophotometry confirmed the clouds' makeup as cesium with just a tinge of sulfur. Ballistic plotting showed the visitor's path to be a cometary hyperbolic destined to pass within the orbit of Mercury in less than three months. Informed scientific opinion showed itself to be torn in three dozen different directions by the appearance of man's first confirmed extraterrestrial visitation.*

When I'd met him at the outer door, he'd said,  
"Percival C. Evans to see Ms. Moss, by appointment."

His hair was shiny black, but his skin was waxy looking, and his eyes were blood-shot. He didn't handle ultra-low-gee well and his clothes were the latest thing from Luna, conservative, with the names of his favorite manufacturers down the seams in three-centimeter-high letters. As he shook my hand, I saw the gleam of a med-alert bracelet at his wrist.

I looked closer, saw the letters, "...lood substi..." before he dropped my hand. That was odd—he didn't seem old enough to be a fluoroglobin user. Maybe radiation leukemia. . . .

He was also worried about something.

"Yes, Mr. Evans. I'm Boo Bailey, Ms. Moss's associate." I closed the door behind him. "This way, please."

He did okay crossing to her office door, so I pretended not to see how he tended to bounce and had to steady himself against the doorway.

I let him into Grandmother's inner sanctorum without comment.

"Mr. Evans?"

"Yes, Madam Commissioner."

She snorted. "I've been retired from the Commission for thirty-four years, Mr. Evans. Please don't use that form of address. Lately, it's become distasteful to me." She paused for a moment. "Please come closer, my eyes are not what they used to be." This was a lie. She'd had lens implants the year before and could see better than me.

He managed to move forward without bouncing off the ceiling. A twentieth of a gee is not much gravity and I knew he'd probably been under half a gee all the way out from Earth. I steered him toward a web chair so he'd have the illusion of normalcy and settled myself over by the bonsai. This is a nasty trick of mine since it puts the grow lights behind me and covers my face with shadow.

Grandmother's desk was circular, completely surrounding her. She pivoted her chair to face him more directly, doing something with her hand that blanked her terminal's display.



Like Mr. Evans, she had a bracelet that meant she went in every two weeks and had two liters of plasma replaced with fluoroglobin, or syntheheme, or synthe-globin—by any trademark, a fluorocarbon platelet substitute to transport oxygen and CO.

She was thin, with fine wrinkles over every visible part of her eggshell skin. She kept her scalp covered with whimple-like hoods because she was mostly bald, and covered the rest of her with loose, colorful jumpsuits that clung at the wrist and ankles, but ballooned elsewhere. She favored Soviet and Japanese corporate names and splashed them creatively across the fabric.

She was 113 years old.

"What can I do for you, Mr. Evans?"

He shifted his hands on his docs-case. "Uh, I don't wish to be rude, Ms. Moss, but what I have to say is extremely confidential." His eyes shifted briefly in my direction.

I waited to see how she would take it.

"Certainly, Mr. Evans." She stood smoothly, coming out of the chair fluidly and floating into the air. As she passed over her desk, she crossed her legs to avoid hitting any keys or switches and lowered her legs again as she floated to the floor near the only other door in the room—the one to her room. "I will leave you to your privacy." The door shut behind her.

I used the time it took him to get his mouth shut to move over to the desk. I perched on one of its bare surfaces and smiled.

He glared back at me. "What did she mean, going off like that?" He'd pulled a handkerchief from a seal flap on his vest and was blotting off his face.

I shrugged and spread my arms. "I thought she was giving you the privacy you asked for. If this still isn't private enough, perhaps I should leave the room, too. And if that isn't private enough, perhaps we *all* should leave. Boy, that sure would make this one private room." I yawned in amazement at it all.

Evans stopped glaring at me and frowned instead. "Could you get her back in here, Mr. Bailey?"

"No," I said flatly. "She rarely moves, period. Once she has, that's it for hours."

"I could go to her."

"She does not see clients in her private quarters."

"Oh." He leaned back and stared at me, clearly trying to figure out where I fit in.

Hell, I stopped trying to figure that out, *years* ago.

I could tell he was worried about my very apparent youth. He probably wasn't too thrilled with my clothes either, since they were monotone black—no company endorsements, no socio/political messages, and no statements of personal philosophy—radical.

Evans stared at me for a while longer. Then he did an intelligent thing. "What do *you* think I should do?"

"Seriously?"

"Yes."

"Tell me what this is about. At least enough to give us some idea, and I will brief her. Then she will call you at your hotel and tell you whether she will do it or not."

"And who else will you tell of this?"

I grinned. "Mr. Evans. You were sent out here by High Commissioner Rostaprovich to find something out. Didn't he tell you *anything* about Ms. Moss?"

He nodded, clearly unhappy. "He said I could trust her with anything."

I shrugged again. "Well, we won't cover up criminal activities, but she's done special projects for the various Commission Divisions ever since she retired. She does not betray confidences. Neither," I added, "does she keep people around her who talk out of hand."

He frowned again, tried glaring, but soon tired of both. Finally he pulled a magcard out of an inner pocket and handed it to me. "Please see she gets this. I think it's self-explanatory."

I took it from him and escorted him out.

Afterwards I locked up and swept for bugs.

I rarely find any, but once in a while. . . . Grandmother's been involved in too many inter-division struggles. We've been bugged by Belt Operations Division

Security, Transport Division Security, the Miner's Union, and several private and occasionally illegal interests.

I even checked that thirty-six-square-centimeter magcard for a thin-layer transmitter and battery (which is tricky, since I had to avoid erasing the six point five megs of information on it). All clean.

I once described these precautions to a visiting tourist and she got the idea that we were *detectives*. Ha! Electronic security is the first thing they teach in any of the ISRC's division schools. On Earth they may think the ISRC is one big happy family doing nothing but the species' work, but up here it resembles the infighting of the superpowers in the 1950s. We just take ordinary, sensible measures.

Grandmother is much closer to an outside auditor, contracted to investigate irregularities that internal audits miss. There *was* the time she uncovered a drug theft ring operating in Transport Division—their cargo manifests were slightly out of balance—but that is *not* the norm. Most of the time, she does sophisticated computer cost/efficiency analysis and spots the problem from her computer terminal.

She never goes out on business. Not only is she too stubborn, but too brittle. Her bones would snap from normal use in a half-gee field.

After I was sure (relatively) that her world was still secure, I buzzed her on the intercom. "You can stop hiding now, the boojum is gone."

She didn't answer, but after a while, she came back into the office and took her desk. "Well, what's *his* problem?"

I said, "No problem. He came by to propose marriage, but I told him you were far too young to be married without your guardian's consent, and that I wasn't giving it."

She blinked and continued to look at me.

"There's a magcard by the reader with his plea. He said he'd keep the ring until you replied."

She picked the mylar strip up and looked at it briefly,

then shoved it in the slot. After it had been loaded into main memory, her fingers started dancing across keys.

I tried once more. "I just didn't think he was sincere enough. He struck me as flighty—the nervous type. I thought he was after your money with no consideration for the finer things in life, like sex, or tag-team monopoly."

The keys stopped moving and Grandmother lifted her eyes from the screen. "Isn't there something else you could be doing, Boo?"

I blinked big, wide innocent eyes. "What, and abandon my ward to big, nasty fortune hunters?"

"Go outside and play."

I grinned and left.

*The visitor began radio communication with all the subtlety of a battering ram. It started with a screeching warble that spanned the radio spectrum all the way from the twenty-meter wavelength to the muddy side of infrared. Radio telescopes, trained on the visitor since its initial sighting, resonated sharply. Their operators threw headphones away in startled pain. Signal-strength meters slammed over and ultra-sensitive receivers, hiked up in gain for the slightest breath of transmission, smoked.*

*Translation: "Is there anybody out there who speaks radio?"*

*Messages flashed across the Earth, jurisdiction was argued, national pride was flaunted. The UN Security Council engineered a compromise. The Lomonosov Center for Radio Astronomy with its international staff was given the task of trying to communicate with the visitor.*

*The Draco Project's three-hundred-meter dish antenna in lunar orbit squirted the first message at the visitor. Pulse, pause, two pulses, pause, three pulses, pause. The visitor's visual message to mankind was beamed back to it over a period of fifteen seconds at fourteen megahertz. Forty minutes later, the visitor's unsophisticated electronic scream switched to fourteen*

*megaHertz and began pulsing in a highly complicated systematic pattern.*

*The scientists at Lomonosov smiled at each other, rubbed their hands, and started to work.*

I spent that afternoon doing a study in cultural biology.

Belt City is a five hundred meter diameter cylinder spinning lazily at one point nine rpm. It is seven hundred and fifty meters long and contains seventy-five percent of the human population outside the orbit of Mars.

To the best of my knowledge, it also has eighty percent of the alcohol-serving establishments in that region of space.

This equates to sixteen bars.

Which has everything to do with cultural biology.

The suspensory ligaments connected to the deep fascia of the pectoralis major support anywhere from thirty to a thousand grams of superficial fascia, glandular lobes, and lactiferous sinuses and ducts—in some cases, even more. But not in *low gee*.

Which makes an enormous difference to the attitude and positioning of a woman's breasts.

I usually start in Bogie's because it's the farthest from center, level fifty at 1.0009 gee. It also features a viewplate dance floor where you can look down and see the stars spinning by, just as if it were glass.

In a one-gee field breasts, even small ones, sag. And I find that perversely interesting.

Which usually means I have to take the elevator up to Ariel's at the hub to see what no gravity does. Ariel's, though, is a tourist trap, with high prices to cover the extra cost of zero-gee bar equipment.

In a zero-gee field breasts, even large ones, don't sag. They achieve elastic balance not unlike malleable soap bubbles.

And I still don't know which is more interesting . . . but I keep researching the matter.

I wish I could give you a glib answer as to my fascination with this particular part of female anatomy,

but I can't. Supposedly I was breast fed a normal length of time as an infant. Maybe it's because I lost my mother at an early age, but I doubt it. The closest I can come to explaining it is that women have them and I don't, and this seems reason enough.

Martha Goodwin, owner/operator of Archie's, flagged me down as I was leaving her place. I jumped over a table to join her. (Archie's is on level twelve, point two two gee.)

She grabbed my legs before I came down and spun me in a quick circle, upside down. "Lout," she said.

"Twit."

"Nerd."

"Ohhh!" I said. "You have wounded me to the quick. You have brought blood welling to the surface. You have clasped death's hand on my soul and. . ."

"Shut up, Boo," she said, and flipped me right-side up again.

"How come you never call me, Martha? Here I am, bearing your child, and you won't even call me once a month."

"I couldn't call you Martha—your name is Boo." She lifted me by the belt until my stomach was in front of her face. "Hmmm, you do seem to be putting on weight."

"Ouch!" I broke her hold with a wrist twist and floated to the floor. "I resemble that remark."

She shook her head. "Two guys were asking after you this morning. They looked like rock miners, but they had money."

"Maybe they hit it big. A half percent finder's commission on a kiloton of praesyidium would pay a lot of bills."

"Ha! You think a find that big wouldn't be all over the belt by now? No, I've never seen these guys before but they looked like the type you find on the wrong end of a lock accident."

"So what did they want with me?"

"They didn't say. Your number's in the city directory, right?"

"Yeah." I didn't get it. What's more, I didn't want to.

"So they probably wanted to find you without *you* knowing about it in advance."

I shook my head. "You have a nasty, suspicious mind. Maybe they're just smart and don't trust the phones. But if they expected *this* to be a safe place, they sure goofed up. Everyone knows *your* tables are bugged."

She made a half-hearted swing at my head with the back of her hand. As I ducked, I couldn't help noting her characteristics *vis a vis* cultural biology, which led to another conversation entirely.

Anyway, it was approaching 1930 when I got home. I'd hit twelve of the bars and gave up happily due to fatigue.

I wasn't droned. The closest I'd come to pharmaceuticals was a glass of chocolate liqueur that Henri Montard of the *Belle* had wanted me to taste. Every place else serves me my usual, tonic and lime, without asking.

Grandmother was torturing plants again.

"Have you talked to your suitor lately?" I asked, doing a two-finger handstand on the edge of her desk.

From over by the plants, she said, "I talked to Mr. Evans thirty minutes ago."

"Oh? When's the wedding? I warn you, I *won't* be maid of honor. I look terrible in pink."

She resumed threading a wire around the branch of a pygmy pine to start it warping in downward curve. She also plucked a handful of particularly healthy looking needles, to cut down sugar production in that area of the plant. "Mr. Evans brought some very interesting data from Misha."

"Misha?"

She nodded absently. "The High Commissioner. Michael Rostaprovich. Around fifty years ago, I had an affair with him. But the man's inconsistent—never could take a set routine. Would never have worked."

"Sure," I said. "I'll bet Evans is exactly the same way. Inconsistent." But my heart wasn't in it. I've seen pictures. She was a heartbreaker, even at sixty.

She began misting, putting a fine sheen of moisture on her pride and joy, the stunted bamboo she'd trained

into a double helix over the last fifteen years. "I want you to look at a graph I've produced," she said. She turned toward the computer and called out, "Harken, graphics file G,R,A,P,H,3,3,5." She spelled out the file name for the computer.

I stopped dancing on the ceiling and flipped down into her chair. The flat screen produced a three-color line graph. The horizontal units were in years stretching from 2019 to the present, 2078. The vertical units were in International Monetary Units corrected to 2070 inflationary values. "Pretty," I said. "I may not know art, but I know what I like."

She finished pruning the bamboo and danced lightly over. "The green graph is the cost of equipment outlay for the development of ISRC divisions over the last fifty-nine years. The red one is the predicted percentage of equipment destroyed, damaged, or lost. The orange line is the actual equipment loss."

I nodded. The green line started out at a nice forty-five degree slope, increased almost to a vertical line, then leveled off to a seven-degree increase over the last twenty years or so. The red line crept along the bottom of the chart, pretty much matching the dips and climbs of the green but at half a percent of its vertical component. The orange line was lower than the red line and became lower still until around 2048, when it started climbing erratically until it crossed the red line, and kept rising until it represented about four percent of the green. Then, to further confuse things, a fourth line of dashed red broke off from the main red line around 2056 and climbed above the orange line, then matched its path, but keeping about three percent above it.

"Okay," I said. "At first, the expected disasters weren't as bad as predicted, and, as time went on and experience increased, they got even less so. That makes sense even to me, but what's this back in '48? I see by equipment outlay that there was a big push along then, but that doesn't explain losses even worse than the opening days of space development."

Grandmother nodded, pleased. "That's right. It



doesn't." She crossed her legs in lotus and floated gently to the desk top. "But, there's more." She pointed at the broken red line. "Sometime in '56, the annual report started using this figure for overall expected equipment loss. And nobody knows where it came from! They didn't even question it; just checked to make sure that actual loss was below it and thought they were doing good!"

I stared at the screen. "Okay. Someone is trying to make the increase in equipment loss seem normal. Why?"

She crossed her arms. "My working hypothesis is that they're trying to cover up sabotage. Perhaps inter-divisional. I don't have the figures yet as to which divisions suffered the greatest losses. Mr. Evans is going to see that I have access to the Commission network."

I leaned back. "I thought there had to be a reason *you* were called in. You're going to start checking the data base for tampering?"

"Right. If there's nothing tricky, we know it was personnel with access at the time—a small group. If it gets tricky, that might tell me something, too."

"Derekin will have a fit." Roberto Derekin was head of Belt Operations Division Security. He thinks there ought to be a commission reg against Grandmother. He's none too fond of me, either.

Grandmother smiled, something she does less than once a month, and nodded her head. "I know."

Director Derekin called the next morning while I was doing body maintenance in the exercise room. Since Grandmother knew I was home, she didn't answer it. I quit stretching and activated the phone.

He's uglier full size, but at half size his features still made me grin. "An honor, Director. To what do we owe the pleasure?"

"Connect me with Anita, Bailey."

"I'm doing well, thank you, and how are you and Mrs. Derekin?"

"Connect me."

I nodded. "Glad to hear it. You know, you really don't call often enough. It's a shame we don't see more of you."

"Bailey!" His face turned red.

"I must say that your skin is looking much better than the last time you called—have you seen a dermatologist?" This was a cheap shot. Everytime he got upset, his face broke out.

He took a deep breath. Paused. Took another.

"Could you hold the line a minute, Director? I have to check on some laundry."

I flipped him to hold and buzzed Grandmother. "Hell hath no fury like a man ignored. One of your other suitors is on the phone—Roberto."

On the screen, she frowned slightly. "Very well, Boo. I'll speak with him. Perhaps you should stay off-camera. You know how you excite him."

"That's 'incite'. I'll patch him through."

I flipped a few buttons and the screen split—Grandmother on one side and Derekin on the other.

Grandmother nodded, "Good morning, Roberto."

That's another thing that burns Derekin about Grandmother. She treats him like a child and he's fifty-two years old. Still, that's sixty-one years younger than she is. Besides . . . she treats everybody like a child.

"We have a request from a Percival Evans to open your terminal lines to the Commission Network with full access." He stopped and looked at her.

She just sat there, waiting.

"Well?" he said.

"Well, what, Roberto? Did you ask a question?"

"What justification do you have for needing this access?"

"I would think that is Mr. Evans' business. Did you ask him?"

Derekin frowned harder, if that's possible.

Grandmother shook her head slowly. "Either Mr. Evans has the authority to grant the access or he doesn't. If he didn't, you wouldn't be trying to find out what I'm going to do with it. And if he didn't tell you *why*, then

I'm certainly not going to." She clucked her tongue at him. "When will the access be changed?"

He started to say something, but choked it off. Then he said, "I was told you would be on line by 1330. You will have full read-access to any section, but will be completely write-protected."

Grandmother nodded.

Derekin broke the connection without another word.

*The United Nations' Agreement on the Moon and other Celestial Bodies created the International Spacial Resources Commission over sixty years before the visitor dropped into man's solar system. For over half a century, the ISRC, or "Company," as it was known, held a virtual monopoly on the exploitation of space. When the visitor began discussing trade between the peoples of Earth and its creators, the Company screamed.*

*From debate on the floor of the United Nations in General Assembly:*

*The Australian Representative:*

*Sacred Trust! They scream to us of Sacred Trust? For sixty years the ISRC has exploited outer space only to pump their profits back into further exploitation, building vaster empires for the Commission's Chairmen. We keep hearing that our foothold must be secure in the heavens before these "angels" we've created can descend to help the Earth. Bah! I say we should disband the Commission and turn its parts over to private enterprise—to companies that will keep the customers satisfied, rather than keep up the same sort of tyranny OPEC practiced when oil mattered. Under no circumstances should the relations with our first interstellar visitor be handled by this parasite of the human race.*

*The American Representative:*

*Colleagues and Friends, much as it grieves me to do so, I must in part agree with the Representative from Australia. The body that so ably undertook the opening of space to commercial exploitation has grown to be an overlarge and unwieldy instru-*

*ment for the furthering of man's place in the universe. Surely, it can be said that the joining of two sentient races is much too delicate an affair to be handled by the ISRC?*

*In Assembly of the United Nations of Earth, February 17, 2045, it was overwhelmingly decided that all relations with extraterrestrial races would be handled by the peoples of the planet Earth by their chosen representatives on Earth. The International Spatial Resources Commission was granted no authority in this area. In fact, pending were debates as to whether the ISRC should have any authority whatsoever.*

*Meanwhile, at Lomonosov Crater on the Earth's Moon, a team of thirty scientists, backed up by thousands on Earth, were trying to pin the visitor down to a definition of terms.*

I spent the next three days reading, writing, and programming—minor consulting jobs for minor clients. I also kept an eye on the news, since the debates about ISRC's involvement with the visitor probe were being beamed in from Earth.

One evening, while Grandmother was maiming plants, I asked her opinion of the matter.

She said, "A dollar short and a day late. The chances of the ISRC being allowed to handle it are negligible. For too many years an ISR Commission seat has been a reward for political favors on Earth. Once a Commissioner is appointed, he milks it for all it's worth."

"You," I said, "were different, of course."

She ignored me and went back to the bonsai.

Friday, four full days after Evans showed up for his appointment, he came again, at Grandmother's request. He was handling low gee even worse, so I surmised he'd been spending all his time on the lower floors of the Hyatt.

"Good afternoon, Mr. Evans," she said when he'd been seated.

"Good afternoon."

"I asked you here to brief you on our progress to date and get some instructions."

He nodded.

"First of all, your surmise that the predicted equipment-loss figures had been tampered with is absolutely correct. Not only have they been changed, the files have been completely replaced."

"How can you tell?"

She frowned, remembered that he was the client, and said, "I wrote the original specs on the current network over forty years ago. You may remember that my commission seat was over Information Services Division."

He nodded again.

"In the particular operating system currently being used, there are thirty-four different ways to create a file. What method is used is dependent on such considerations as file size, number of users, how often it is to be accessed, what sort of access, and what form of information is to be stored in it. This lets the system use the most efficient method in accessing them. Suffice it to say that the files reflect this information in their header blocks, and by examining them, I can tell which method was used.

"The files in question are normally created using a catastrophe analysis program called RISKAN, and use one particular method of file creation. The header blocks did not reflect this. In fact, the method of file creation used is common to any of several file examination and repair programs."

Evans spoke. "But if the headers have been changed, why was the master budget program able to access the information?"

She leaned forward. "Because it doesn't matter to the operating system. If the expected method doesn't open the file, the OS just runs down the various file types until the file opens. It won't report an error until it has tried every one of the thirty-four ways. This is obviously less efficient, but is more forgiving when different computer systems have to interface."

"Now, more to the point, I have also been able to determine which terminal group generated the file in question. So, I pulled the personnel files for that area and time to see who would have access and the knowledge to create and insert the new file."

"And?"

She leaned back. "None of them could have done it. The terminals in question are palmprint locked to a group of file clerks, all of them barely competent at their own jobs, much less sophisticated computer crime."

Evans frowned, leaned forward. "Maybe one of them accessed the system and let someone else use it."

"I considered that," Grandmother said, "but decided to check something else . . . I examined the header blocks on the personnel file—it too had been replaced. For that reason, I think that the person who made the changes *was* in that file, but wiped his own record to avoid tracing."

"We could question the clerks directly. They could probably pinpoint a fellow clerk who doesn't show up on the personnel roster."

"Good luck, Mr. Evans. That change was made in '56, twenty-two years ago. According to records, those clerks no longer work for the commission. You may be able to track them down, but even then, who's going to remember?"

Evans licked his lips. "What do you suggest?"

"I programmed a search of commission personnel files, system wide. I looked for the same sort of altered files at any date later than 2070." She held up a sheet of hardcopy. "These seven departments are the result. Four of them are in Belt Operations, one is in Transport, and two are in Systems Administration, on Luna."

Evans blinked his eyes rapidly. "I never dreamed anybody but personnel could change those records."

Grandmother shook her head. "A system programmer or analyst of sufficient rank could. Also security."

"What is the next step?"

"That's for you to decide. I would recommend that you turn this information over to someone with the

authority to question the employees in these departments. Some trace of the perpetrator should turn up."

"No," Evans said flatly.

Grandmother nodded. "I thought that would be your attitude. You are unwilling to release this information until you know who is behind it and why."

"It could be *anybody*. Can you continue the research?"

"Only if you can authorize me and my agents to question any Commission personnel necessary. Also, you can expect interference from local Security. They will want to know what is being investigated."

"Director Derekin has already been pressing me for info." He mulled it over. "Okay, I'll have to telex the High Commissioner, but I'm sure you'll have authorization by tomorrow."

"Very well," she answered. "We'll prepare a course of investigation."

After I saw him out, she leaned back in her chair and sighed.

I nodded in sympathy. "That was tactless of him, sticking to business when you were dying to throw yourself into his arms."

She grimaced, then hit a key on her console. "What's my next step?"

I laughed. "*You're asking me?*"

"Call it an exercise in education. What would you do next?"

"Part of it's obvious. If the personnel files in Trend Analysis were tampered with to hide whoever had been tampering with the stat files, then what are they trying to conceal in these other seven departments? What files have been switched or modified? What sort of information changed?"

"Surely. I've started that search."

"Well, then, how about examining the incidents of equipment loss over the last twenty years for patterns?"

She nodded. "That one has also been initiated."

"Oh." I gnawed on it a little more. "Then why don't you send me out to buy some software?"

"That does not follow logically."

"Sure it does. We're talking about an individual or individuals who are more than just competent at system interaction. I've got a line that should work without heavy authorization, and better yet, without alerting our target. I'll give you three-to-one odds on my finding something before the authorization comes through."

Grandmother pursed her lips. "It would get you out of my hair." She nodded. "I'll download the personnel files to your console. Prepare yourself."

I grinned and jumped.

*"Well, what on Earth does the bloody thing say?"*

*The analyst pushed his chair back and flipped his pen into the air. It floated up in a leisurely arc until it just brushed the ceiling, then descended as slowly. Without looking, the analyst reached out and captured it again.*

*"That's hard to say," he told the reporter. "You've read the document, haven't you?"*

*"Sure I have, but I've also read (The Canterbury Tales) in the original. I needed help with those, too."*

*The analyst chuckled. "All right, you want the Reader's Digest condensed version with all the lumps removed." He picked up a sheet of printout from the console before him. "In essence, the treaty is a general agreement between the Peoples of Earth and the Builders of the Visitor to maintain a steady social and economic intercourse at the first opportunity. The document guarantees them the right to sample all the world's markets, to taste the complete diversity of our world's cultures." He paused and looked out the window to the distant crater walls. "They don't have faster-than-light travel, so it isn't worth their trouble to send a manned trading expedition to a suspicious closed world."*

*The reporter scowled. "But I thought the visitor said trade could begin as quickly as seven years from now, and there isn't a star within seven lights-year of us in the direction it came from."*

*The analyst sighed. "I warned them against playing that up. We've gone over that point with the probe*



several times, using several different time definitions—the orbits of planets, the speed light travels from the sun to Earth—and we get the same answer. We've decided that there is already an expedition heading in this direction. Whether it decides to stop in our solar system or not depends on the visitor's success in obtaining this treaty."

"What about the language of the thing? All these terms like 'Creatures of Planet 500 light-seconds Out of System Primary' and 'Makers of Probes'."

"Well, what do you expect? We have barely begun to learn how to communicate with the visitor. The experiences we share are extremely limited. In fact, it's highly improbable that the probe even thinks, but is instead an extremely sophisticated computer with some capacity for self-programming. If we could bring the visitor down to Earth and show it what we're discussing, share with it more background experience, then we could make great leaps and bounds in progress."

The reporter tilted his head and spread his arms. "Well, why don't we? Send a ship after it and bring it here?"

The analyst snorted. "Didn't they teach you anything about physics before your agency sent you here, or are you sleeping with the publisher's wife?"

The reporter thumbed his nose. "My business. Answer the question."

"We can't even get close to the probe. It's in an orbit completely perpendicular to the plane of the ecliptic." He held up his hands at right angles to each other. "Even if we had a ship close, it would still be in the plane of the ecliptic. There isn't any sense in an orbit at any angle to the solar system's plane unless you're going to Pluto. That is, there wasn't any sense until now." He crossed his arms. "The most we could manage is a flyby when the visitor rounds the sun inside the orbit of Mercury. Even then, the relative velocity would be almost sixty thousand kilometers per hour. Sort of like trying to read a sign on a train when it's going the opposite

*direction of the train you're on. Here it comes, flash, and it's gone."*

Preston T. Pau was department supervisor of Equipment Inventory Control for Belt Operations. He was from Malaysia and his English had a British flavor.

I entered his office and said, "It was kind of you to see me on such short notice."

He waved me to a chair. His offices were in the high-gee section of the Commission's end of Belt City, and the seat was welcome. "Think nothing of it, Mr. Bailey. We're always glad to clear problems up. What can I do for you?"

"Well, let me tell you a story. Sometime in August of 2072, our client, Horstman Software, received a demo copy of a software package that was unique, well written, but not particularly useful—at that time. They returned the package with a polite note rejecting the software, but asking to see any future work that person did. They never heard from them again and the file with the name and address was subsequently wiped." I paused and shifted in my seat. "In the meanwhile, a certain type of software came into wide use—one that dovetailed very neatly with the software package Horstman received that August. Now they want that particular package and badly. They feel it would make a fortune for them and the author, but they no longer know who the author was!"

Pau frowned. "I see their problem, but fail to see where we could help."

I nodded. "Horstman has recalled one thing aided by hypnoanalysis—the address on that package was your department."

Pau blinked, then leaned back in his chair. "August of '72? Hmmmmm. I was transferred into this department in '74, so I have no personal knowledge of the period." He touched a button on his desk and a voice answered.

"Stayson."

"This is Preston, Joseph. Do you have a minute?"

"I could find one."

"I'm going to send a Mr. Bailey to talk to you. He'll be right up."

"Send him on."

Pau stood. "Joe Stayson has been with his department since '69. If anyone can help you, he can." He walked me out his door and down the hall to a lift. "He's on level eight. Take a right out of the lift, and it's the first office on the right."

I smiled and thanked him profusely. He shook it off like a shower and went back to his office happy to have delegated another chore. A good executive.

I got off the lift *much* lighter than when I got on and followed Pau's directions.

Joseph Stayson was a young, rumpled man with a receding hairline. I found him standing loosely behind a chest-high desk piled with computer hardcopy and empty coffee mugs. Stayson stuck out an arm and loosely shook my hand. His greeting was artificial, clearly memorized for social occasions. I didn't waste a lot of charm on him, but simply repeated my story.

He blinked twice, and said, "Jean Rowan."

"I beg your pardon?"

"Jean Rowan. If your client is right about the address and the time, the author was Jean Rowan."

"How certain are you?"

"Positive. I'm a good programmer, but she was better. She came in July of that year to do an audit of computer procedures and left in September. I recall it vividly. She was a better analyst than I was and she wouldn't have a thing to do with me." He blinked again. "I remember. I was in love with her."

I tilted my head to one side. "Do you know where she is now?"

"No . . . and I've tried to find out."

"City guide? Commission directory?"

He shook his head. "Negative. I tried personnel, but they don't give out anything. The only clue I ever had was a picture of her in what she said was her apart-

ment. She gave it to me the last day she was here—pyrrhic victory.”

I straightened up. “May I see it? I won’t hurt it, but it could be very important for her.”

He frowned, and his mouth looked like he’d just bitten into something rotten. Then he pulled open a drawer and shifted papers around until his hand came out with a twelve-by-sixteen centimeter photograph. He took it by the corner and flipped it through the air at me. “Take it,” he said. “I never want to see it again.”

Robin Wilson, of Belt Operations Accident Control, looked at the picture and said, “Roberta Ash, but she was blond when I knew her,” and “No, I’ve no idea where to find her.”

Sally Mander, of Belt City Sewage Control, eyed the photograph and said, “Linda Maples looked better as a redhead,” and “I thought she went back to Earth.”

F.X. Herzig, of Seismic Surveying, handed the picture back to me and said “Darlene Birch, with darker hair than usual,” and “Whatever became of her?”

I said, “I don’t know . . . but I’m going to find out.”

Grandmother used a digitizer on the photo and put it on the wall screen one meter square. I bounced slowly between the ceiling and the floor while I looked at it.

Jean Rowan a.k.a. Roberta Ash a.k.a. Linda Maples a.k.a. Darlene Birch—in other words, the person in the picture, was a woman anywhere from twenty to forty years old. She had fair skin and a nose slightly too large for her face. Her eyes were green and she seemed slightly underweight, but this was hard to tell because she wore a flowing caftan that concealed everything but her head and hands.

She was seated in a circular lounge chair, the kind made for an intimate two at the most. Behind her on the wall was a graphic print of an early Soyuz launch in a chrome frame. The wall itself was light blue. Beside her on a small table was a tall clear glass with a straw

and a dark liquid in it. In a small vase behind that was a flower.

"What's the flower?" I asked Grandmother, since I have limited experience with these things.

She frowned. "It's an orchid. Stupid plants—they're epiphytes . . . parasitic." She leaned closer to the wall. "I've tried to make an I.D. on the face, but any record has apparently been wiped. She's not in the records anymore."

"Too bad. What about the apartment? Think we can locate it?"

She stopped frowning and stepped back from the picture again. "Perhaps. Tell me, Boo. What level is it on?"

I looked at her out of the corner of my eye. She wasn't looking at the picture, so I knew she'd spotted something. I looked at the blowup again and tried to see it myself.

If I'd ever seen Jean Rowan in the flesh, I might be able to tell something from facial sag, or lack thereof. Because of that voluminous caftan, I couldn't tell whether her breasts were sagging or just small. The orchid could have been old and just curled up from lack of hydrostatic pressure, or fresh and bowed down by a full gee of gravity—or plastic, even. I didn't know beans about orchids.

"I don't know."

"Look at the drink."

"Damn. The straw. The fluid's pretty high, isn't it?"

She nodded, satisfied. "Yes. That apartment, if it's in Belt City, is somewhere between levels ten and four."

I moved back to her console and was calling up the city map when the phone beeped.

Grandmother turned the wall screen off. I turned on her desk phone and found myself looking at Mr. Percival Evans.

"Good afternoon, Mr. Evans."

"Mr. Bailey—I have a favor to ask of Ms. Moss. I have been invited to dine with Commissioner Hall and some of his staff this evening and was asked if Ms. Moss

would join us, as well." He paused. "It's probably an attempt to find out what I'm investigating, but they *might* reveal something themselves. What are the chances of Ms. Moss joining us?"

I looked over the screen at Grandmother. She was thinking it over. I asked, "Where is this dinner to be held, Mr. Evans?"

"Roark's, on the twelfth of level of the Hyatt. According to the Commissioner, that's the only restaurant Ms. Moss frequents."

Grandmother moved around until she was in the camera's range. "I would be delighted to accept, Percy, if the invitation is extended to Boo."

He nodded sharply. "Done. Apparently the Commissioner knows you quite well. He said, 'and she'll probably want to bring Boo Bailey if she decides to come.' I'll see you at nineteen, then?"

"Certainly, Percy."

He clicked off.

I raised an eyebrow at Grandmother. "Percy, is it? My, my. His suit is going better than I thought. I guess you synthetic blood types have an affinity for each other."

She looked at me. "Mr. Evans uses a blood substitute?"

I shrugged. "He wears the bracelet."

"Interesting. There aren't that many of us." She walked over to the bonsai. "See if you can run down the probable location of that apartment in the next half hour before you have to get ready for dinner. Mustn't keep Uncle Hal waiting."

*Outbound, the visitor received the news from Earth.*

*In General Assembly of the United Nations of Earth, the human race ratified an agreement of general intent—that the beings inhabiting the third planet from the sun would welcome and encourage trade with the builders of the extraterrestrial probe known as the "visitor".*

*There was a pause as the message traveled the ever-increasing distance to the probe. Then the message was repeated back to Earth rephrased, but unaltered in*

*content, with an affirmative behind it followed by a specific inquiry symbol. "This is what you are saying—yes?"*

*Earth confirmed with a triplet of affirmation symbols and held its breath.*

*Fifty minutes later the visitor replied with the symbol for Earthlings and the symbol for its builders, joined with the strongest conjunction of their makeshift language.*

*Then it vanished.*

Roark's was a leisurely thirty-meter stroll out of the apartment and around the curve to the Hyatt proper, then up a "stairway" to level twelve. Grandmother will not get on a lift. Who knows when some minor malfunction will take it *down* instead of up, and she'll find herself in a hostile acceleration gradient?

The restaurant had a balcony overlooking central park, a cylinder within a cylinder. You can look down (or up) to see grassy slopes, trees, and swimming pools. The grass was at level 40—three-quarters gee.

We were shown to the private room in the back. Gathered there was Commissioner Halloran Hall, head of ISRC Belt Operations; Roberto Derekin, his security chief; Anne Bogucki, Belt Operations Personnel chief; Laura LeHew, Legal Section; and Percy. They were standing around a bar at one end of the room drinking and talking.

When we entered they shuffled around, smiles and good cheer. Uncle Hal came forward, pecked Grandmother on the cheek, and shook my hand firmly. "How's it going, Boo?"

I just smiled.

Let me explain something now. "Uncle" Hal is not my uncle any more than Anita Moss is my grandmother, but they are family just the same. Both my parents died when I was two and several executives in the ISRC adopted me. There was no family to send me to back on Earth, and they felt responsible. Like real family, I'm also stuck with them. I didn't choose them any more

than one chooses real relatives, but I'm happy that some of them ended up "related" to me.

Uncle Hal is one of them I'm mostly happy about.

I won't say how I feel about Grandmother—she might read this and I'd rather bug her.

Offers of drinks were made and I took tonic and lime. Grandmother took a glass of mineral water. The conversation resumed where it had stopped when we came in: when, not if, the UN would dissolve the ISRC.

It was interesting the way they polarized. The older they were—Percy, Uncle Hal, and Grandmother—the more inclined they were to see it as a natural step, while the newer appointees—LeHew, Derekin, and Bogucki—were resentful. I kept quiet and listened, looking for the odd probe into Percy's investigation.

While the waiters loaded the buffet, Derekin looked at Grandmother and asked, "How's your investigation going, Anita?"

I shook my head. Subtle stuff.

Grandmother just smiled.

LeHew and Bogucki were arguing a point of space law with Uncle Hal by the buffet. LeHew snared a few samples off the passing trays. Bogucki leaned over the lobster almondine and inhaled the fragrance. "Good stuff," she said. Uncle Hal tested a piece of ham and said, "Better come and eat before we throw it out."

Derekin stepped aside for Grandmother, but she just waved him on. As I moved up to the buffet I saw her snare Percy with her eyes. He hung back and listened to her for a moment. I saw him shake his head in response, then they joined us.

During supper, we talked about the visitor.

"What are its makers like, I wonder?" said Laura LeHew.

Uncle Hal told her, "They are the most hideous form of life in the galaxy—capitalists."

"Just so they aren't bureaucrats," I said.

This got a bigger laugh than it deserved, but it was the first thing I'd volunteered all evening.

Laura started a complicated lecture comparing the



language of the original UN ISRC charter and the statement of intent negotiated with the visitor. I tuned her out and watched the group.

Grandmother was doing her usual imitation of a bird, sampling this and that, but not eating heavily. She did, however, send me back for more of the lobster. Uncle Hal was doing justice to everything, while Anne was a close second. Percy ate a lot of the lobster, but stuck to salad and bread after that. Derekin was too busy trying to watch everyone to eat much. And Laura was talking too much to eat a lot.

Grandmother had put down her fork and was starting to dismantle the whole of Laura's argument with a few well-chosen questions when Percy keeled over.

In a twentieth of a gee, one doesn't fall very fast. I had an arm under him before he was halfway to the floor. My other hand checked his pulse.

He didn't have one.

Uncle Hal is the division commissioner. Grandmother knows everybody, from several heads of state to the High Commissioner. Laura LeHew and Anne Bogucki are bigwig department heads. So who do they pick on?

"Again—why'd you put the poison in his food?"

There weren't any bright lights. They weren't towering over me and screaming in my ears. But it wasn't pleasant.

Derekin would have loved to take me back to his office and have a go at me with all the wires hooked up and the reticular formation of my brain awash with phenobaritol. Instead, he had to sit back in the corner of the room and let Captain Vaslov of the U.N. Civil Police conduct the interview.

"What poison?" I asked for the sixth time.

What upset Vaslov was my lack of fear. He was used to fear—he expected it even in the innocent. This was the Russian attitude and the result he got even with non-Sovs.

I was so tired of sitting there in police headquarters at a full gee that I decided to try logic.

"Okay—try this for size. If you've questioned the others, you know I sat at the end of the table away from Mr. Evans. He went through the buffet line *after* I had already sat down, and there was *no way* I could have sprinkled poison on his plate."

Vaslov grimaced. "We know that—the poison was put in the lobster almondine on the buffet."

I looked at Vaslov. "Damn selective poison—what was it? An allergen that Evans was sensitive to?"

Derekin growled. "We're asking the questions, Bailey."

"Hey, guys. I've got a right to know. If I didn't put it on the stuff, then someone did it before I served myself. What did I eat?"

Vaslov exchanged glances with Derekin.

"It was a diamine amino acid analog," said Vaslov. He watched my face carefully as he said it.

I shrugged. "Is that supposed to tell me something? I didn't think amino acids were poisonous."

"This one isn't. Not to me or you, but then we don't have two or three liters of fluorocarbons floating around our bloodstreams, do we?"

I stood up so quickly that Derekin's hand dove toward his pocket.

*"What are you talking about! Where's my grandmother? How is she?"*

Vaslov held out a restraining hand. "Hold on. Hold on. You're grandmother's fine. I was told that she left the clinic a half hour ago and is resting at home."

"What did the stuff do to her?"

"Nothing," Vaslov said.

The intercom buzzed. Vaslov said, "*Slushaiyoo.*"

"We've received the samples from Robertson Clinic, Captain. It is as I thought."

"Very well, Kareega. We'll be right there." He then turned to me. "Come down the hall with us. I want you to see something."

I'd never been in a morgue before.

Kareega was from Zaire. He was a forensic chemist. When we entered the room he was pouring a translu-

cent fluid out of a bottle into an open beaker. When we were closer he began lecturing.

"This is a mixture of blood plasma and fluorocarbon blood replacement removed from Anita Moss an hour ago. We've already determined that it contains a proportion of the diamine analog distributed evenly through the solution." He held up the bottle and peered through it.

"What does that do to oxygen transport?" I asked.

Kareega blinked, thought about it. "Nothing, I should think. It should also still carry CO<sub>2</sub> four times better than oxygen."

I was still a little shaky. I interrupted him, "Then what killed Evans?"

Vaslov said, "Excuse him, he's young."

"Right," I said. "And that's my Grandmother's life fluids in that jar."

Kareega ignored us and went on as if nothing had happened. "Evans was killed when the fluoroglobin in his circulatory system polymerized."

"Huh?"

"The fluorine groups of the fluoroglobin underwent nucleophilic attack by the amine groups of the analog with acid catalyst, forming long-stranded polyelastomers."

I looked at him blankly.

"Look." Kareega took a medicine dropper out of another bottle and held it over the beaker. "This is carbonic acid." Three drops fell. Almost instantly, the fluid changed color, became darker. He took a stainless steel spatula, dipped it into the mixture, and brought it up. Draped over it were irregular strips of translucent material. Kareega looked from the solids on the end of the spatula to me.

He spoke slowly, as if speaking to an idiot, "His blood turned to rubber."

I looked at Vaslov. "Are you *sure* Ms. Moss is all right?"

He nodded.

"Why wasn't my grandmother affected?"

"She's not a diabetic," said Kareega.

When I didn't say anything, he went on.

"The reaction is twofold. After the diamine analog attaches to the perfluorocarbons, an increase in acidity is sufficient to catalyze the resulting polymerization. Mr. Evans is an advanced diabetic. His blood tends to acidosis normally."

Derekin spoke. "Which is fortunate for your grandmother. Her blood pH was normal, as you know."

I stared at him. Impatience got the better of me and I said, "You really are an asshole, Derekin."

"You and your grandmother engineered it, didn't you?"

I turned back to Kareega. "You're saying that my grandmother's normal blood pH kept the same thing from happening to her?"

Kareega's eyebrows went up. "There is hope for you. Diabetics have a tendency toward blood acidosis because they accumulate organic compounds like Beta-hydroxybutyric acid, etcetera. Still, even if he hadn't, the balance would have been tipped when he slept—that would have accumulated enough CO. Ditto for your grandmother."

"How did they treat her?"

"Total blood replacement plus administration of some compound with a high affinity for the diamine analog. Probably something with a long arm of carbohydrate moieties so the liver would get rid of it."

I nodded and stared over his shoulder. My mind was racing and getting nowhere at all.

Vaslov took me back to his office. Derekin came, too. Pity.

"I'm willing to adopt a working hypothesis, Bailey. For the time being, I will assume you didn't have any direct connection with Mr. Evans' murder."

"Whoopee."

Derekin said, "Watch it, Bailey."

Vaslov continued. "But this still leaves the matter of *what* you and Ms. Moss were investigating for Mr. Evans and High Commissioner Rostaprovich. I have no choice but to assume that this inquiry was the reason

behind his murder." He sat down behind his desk and folded his hands together. "We have asked you before—what was the goal of your investigation?"

I blinked. It was two in the morning. I was tired. "As I said, you'll have to get that information from Ms. Moss. I am not at liberty to say."

"You realize that whoever was trying to get Evans was trying to get Ms. Moss, as well?"

I shook my head. "Possible—but not definite. It could have been coincidence."

Vaslov leaned back and suddenly looked tireder than I felt. He said, "*Obrataet*," and his intercom buzzed again.

"Yes, Captain?" a voice asked.

"Alert lock control of an egress prohibition for Anita Moss and Boo Bailey. Forward their retinal patterns from records for their scanner."

"Anita Moss and Boo Bailey. Yes, Captain, at once."

He turned back to me. "That leaves you the run of the city. On pulling your record, I see you haven't been out in two months, anyway."

I didn't say anything.

"I will be calling on your grandmother tomorrow at ten. Please inform her."

Grandmother was waiting for me when I got home.

"You should be resting," I said tiredly.

She snorted. "Do you think I stayed awake through the blood replacement? I was asleep for hours."

"Oh."

"Tell me about it briefly—you can give me more in the morning."

"Vaslov is coming tomorrow at ten. He wants to know what we were investigating. I didn't tell him. He's restricted us to the city and told lock control to make it stick." Then I told her about the poison.

She nodded. "Dr. Rao told me that. It would have been interesting to see it polymerize, though." She raised her index finger to her nose. "I've sent a coded telex to High Commissioner Rostaprovich asking him

for direction. Hopefully, I'll get a response before Vaslov arrives."

"Okay. Anything else?"

"Set your alarm for eight."

Five hours sleep isn't at all bad in a twentieth of a gee. Not the six hours I usually get, but enough. I found Grandmother at her desk.

Before I'd opened my mouth, she asked briskly, "What progress did you make in tracking down the apartment of that Rowan woman?"

Well, good morning to you, too, I thought back. "It was either in the Hyatt, the Hilton, or in the block of condos closest to the North Lock. I know our neighbors in this area, and every other residential area is in heavier gee."

"Okay—get out of here and track it down before Derekin or Vaslov shows up. You can eat breakfast someplace else. If you find anything, call on the scrambler and see if it's safe to come back."

"Oh, yeah?" Awareness dawned. "You got a response from the High Commissioner."

"Yes." Her voice shook. I was shocked when I realized it was barely contained rage. "The Commission denies any involvement or responsibility for Percival Evans' actions. They say to the best of their knowledge, Evans was on vacation. That's the official line."

"Nuts! Does that mean there's an unofficial line?"

"Misha sent me a coded response. Although he approved of Evans' investigation and privately supported it, the majority of the commissioners felt that this wasn't the time to rake up dirt—with the debates on the ISRC Charter Renewal coming up. He says he can't be implicated." She folded her arms. "Derekin also cut my access to the network."

I nodded. "Figures."

She made shooping motions. "Get out of here. I'll handle Vaslov, but I don't want to hand him everything until I know what's going on."

\* \* \*

I ate breakfast at Archie's.

"Those two guys were here again, two nights ago."

I looked up from my eggs and roe. "Sit down, Martha. I want to play footsies."

"Hal! That was never a part of anatomy that interested you." She sat opposite me.

"Were these persons asking after me again?"

She nodded. "They were indeed. Do you still not care?"

I scooped the last bit of roe onto toast and chewed. "I guess I've gotten to the caring stage. Can you tell me what they looked like?"

"Better. I can show you."

"Oh? You tape them?"

"Yeah. Got them on the cashier's camera."

I dropped my napkin on the table and followed her back to her office.

"I thought you said they looked like rock miners?"

She looked up from the screen. "Well, that's how they looked the first time I saw them. I hardly recognized them when they showed up like this."

"This" was in formal evening wear, tight pants, and padded jackets. The big one, slightly balding, went in for typical corporate ads—a Stolichnaya Vodka logo on his jacket and ad copy down the seams. The other guy, about my size, went in for abstract juxtapositions of male/female anatomy. Across his shoulders was the statement, "Treats Women with Respect."

I didn't recognize either of them, but the population of Belt City is over 60,000, plus a large transient pool.

"Never seen them before, kid, but I'll keep an eye out."

In return for certain economic incentives, the bell captain in the Hyatt said, "Not in this hotel. I guarantee it."

I knew the bell captain of the Hilton, so the incentive was a promise of dinner and dancing, before she told me, "No. We don't have anything that looks like that. The furniture is all wrong."

That left Cramer House, the exclusive set of condominiums near North Lock.

I stopped at Lily's Fashions to make one purchase. Then I started the approach I'd decided on.

It worked the fourth time I tried it.

She was a waitress at the small cafe owned and operated by Cramer House. I sat down at one of their undersized tables and when she came up with the menu, I said, "Just coffee, please, but perhaps you could help me in another matter."

"Sir?"

I lifted the purse I'd bought at Lily's. "I found this purse down the hall. When I looked inside, all I found was this picture and an awful lot of money. I'm betting this woman owns the purse, or would at least know who does. Do you recognize her?"

She picked up the picture. "Sure. That's Ms. Oakley. She lives in twenty-six."

Bingo.

"Well, thank you. Here, forget the coffee, but take this." I laid a ten-IMU note on the table. "I'm sure Ms. Oakley would want you to have it. Does she eat here often?"

"No, sir. She used to, but I haven't seen her in months."

I left.

The condo was on level four, slightly under a twelfth of a gee. Number twenty-six was fifteen meters down a corridor from a public lift. I had a *Below the Belt News* terminal print me a copy of the latest edition, and settled down on a bench with a clear view of her door.

Evans' death had made it past ISRC censors. Vaslov hadn't issued a press release, but Derekin had, claiming that progress was being made in the investigation, and that certain suspects would be arrested within forty-eight hours. There wasn't the slightest mention of what the motivation might be. Evans was described as a senior ISRC official vacationing in the Belt.

I hoped Vaslov was pissed at Derekin.



In other news, a large molybdenum strike stimulated trading on the world steel markets. The appropriate bodies had been accelerated and would arrive in the vicinity of the Belt City smelter in two weeks.

In a freak accident, a scrow carrying two hundred cubic meters of raw sewage from Ceres station lost two valves and half its cargo sixteen thousand kilometers from Belt City. There was some concern at first, but calculations showed that mirrors in the vicinity of Belt City were in no danger of fouling. Certain scatological puns were made.

Bellomy's was having a sale on recreational drugs, and K.P. Mitchell's was advertising second-skin suits at twenty percent off.

Rowan/Oakley left her domicile on my third time through the paper, three hours after I began my vigil.

At first, I didn't know it was her. All I saw was a woman dressed in red coveralls with Bell Aerodyne logos come out of the door marked twenty-six. She was carrying a large bag, the kind typically used to carry personal pressure equipment, and she turned right, going away from my station.

I was on her quick, jogging down the same corridor and passing her, like a man in a hurry. She glanced at me as I went by.

It was her all right.

I took the next right and slowed down. The first phone booth I came to was occupied, but the second wasn't. I ducked into it and pulled off my jacket, all the while looking back toward the other corridor. She went straight. I slung my jacket over my shoulder and followed.

She ended up where I was afraid she would—North Lock.

I lingered with a mixed crowd of executives, tourists, and private pilots while she processed through Lock Control. The crowd was upper crust. At South Lock, the industrial port, the crowd would've been miners, techs, catchers, and pitchers.

I scrambled up a side passage, floating more than walking, to the observation lounge. There was no way I

could follow her through Security. Even if I did get past them, there was no way traffic control would allow me clearance for the *Johnny-Go-Lightly*, Grandmother's rock buggy. Not with Vaslov's down-check.

Through the glass I saw Rowan/Oakley skip over to the women's lockers. Fifteen minutes passed before she came out. She had on her skin suit, plus an insulative coverall, zipped open to her waist. Her helmet hung from her shoulder, on a strap. She carried a small hard case for her vacuum sensitives.

I groaned. If she'd just gone to the terminal side of the lock inside of the private pilots' port, I'd have had some idea where she was headed. I pulled myself down the rail until I was looking out into the huge circular hangar bay, and open space.

For a charge, you could listen in to the lock radio traffic. I slipped some IMU fractions into the slot and put on the headphones.

She came through the lock ten minutes later, taking plenty of time to test for suit problems. I switched the channel selection to traffic control. She kicked across to one of the thirty staging platforms where the lock crew had already stationed a medium-range, two-ton ship. She must have phoned ahead, arranging for fueling and staging before she left the condo. I jotted the registration number and name down on the back of my right hand as she entered and pressurized.

"Traffic control, this is November Zebra one eight three, requesting clearance for egress."

"Roger, Ms. Oakley. *Black Orchid* is cleared for egress on pre-filed flight plan at eleven five six. Repeat—one one five six."

Damn. No mention of destination.

The *Black Orchid* was resting on three extended pads, very slight centripetal force keeping it in place. She waited the five minutes until 1156, then kicked off the pad with a burst from side thrusters and moved out of the hangar against a backdrop of slowly revolving stars. As I watched, the ship seemed to start turning,

but I knew she was killing the two-RPM rotation she was carrying from the city.

Once clear of the lock she kicked in her main engine and drifted out of sight. I reached in my pocket for more fractions and moved down to where the radar repeater tanks were.

The first one didn't work when I dropped the money in. I walloped it over the fraction reader, but it didn't do anything. Swearing under my breath, I moved to the next one and put my last half-IMU piece in.

It lit up.

*Black Orchid*, identified in the tank by a small blip with the designation NZ183 below it, was accelerating with respect to the orbit of Belt City, staying in the plane of the ecliptic, and incidently the plane of Belt City's rotation. I took down the vectors and watched for a change in acceleration that would indicate she'd stopped thrusting. It came five minutes later. I noted the velocity attained, forty meters per second. That jibed with the average acceleration for a ship that size, about fourteen micro-gees.

An idea, unbidden, unwanted, and dangerous flashed into my brain. I grabbed the rail for a moment, while reaction washed through me, twisted my guts, and left me gasping. I wanted to throw up, but controlled the urge. When the feeling passed, I was grinning.

It might work.

"No, I forbid it."

"Don't be silly," I said. "I haven't asked your permission."

I was in a public phone booth, on level thirty, having just made certain arrangements with a retailer of vacuum gear. When Grandmother answered the phone and found scrambler garbage on the screen, she'd keyed our code and synched in.

"I can tell Vaslov about the girl and have him send a vessel after her."

I could tell by the way she said it that it was the last thing in the world she wanted to do.

"How *was* your interview with Vaslov?" I asked.

Her voice started shaking again. "That *man*! I . . . are you determined to do this?"

I nodded. "For many reasons."

She looked at me for a full ten seconds. "Very well. I'll give your gear to Ms. Goodwin, when she comes by. Have her be careful. Vaslov was *not* pleased when you weren't here earlier. I'm sure he left someone outside."

"Right. See you later."

"I hope so."

She switched off, and suddenly I found myself looking at my reflection in the darkened screen—a very young, very uncertain reflection.

I thumbed my nose at it and left.

The man was wearing a faded Rolling Stone vest ensemble with patches. Quite a change from the Stolichnaya suit I'd seen him in on Martha's tape.

His accent was Australian and he had a knife.

"They can do wonders with dacron, boy. You survive the blood loss and they'll build you a new trachea."

I stood very still while the cutting edge rested against my throat.

I had been heading for Archie's when an arm had come out of a side hall and grabbed my jacket collar. The next thing I knew, I was standing in a maintenance closet next to vacuum cleaners and mops.

The door opened again and his co-star appeared, the short one who'd worn the erotica on the tape. He closed the door behind him. "It's clear to the lift. Light traffic."

The big one tightened his grip on my collar. The knife moved slightly on my neck. "Listen very carefully, Mr. Bailey. We're going to walk casually to the lift, get on it, and go down to level fifty. I'm going to walk behind you. My friend here is going to walk beside you. He also. . . ." The short one's arm moved and something went *snick*. Something long and shiny

appeared in front of my eyes. “. . . has a knife,” continued the big one.

“Why?” I croaked.

“He gets lonely without a knife.” The grip relaxed marginally. “It was asking questions that got you into trouble in the first place. Let’s not reinforce any bad habits.”

The door opened outward and the short one moved out into the hall, holding his knife blade down, by his leg. The knife came away from my throat and the big guy gave me a gentle shove.

As I cleared the door, I slammed it on him.

“What. . . !” said the short one, before I rebounded off the door into him. I tried to make the contact all knees and elbows. He didn’t have time to lift the knife until after he hit the far wall. The big one grunted something and managed to get around the door, but I was four meters down the hallway and accelerating.

They recovered quickly. I was hoping they wouldn’t be able to handle themselves very well at a fifth of a gee, but they ran right along behind me, sort of skating instead of thrusting hard enough to bounce off the ceiling. That meant they were local, or maybe from Luna. I gained some room when I banked around a corner by running on the wall. That was a trick they didn’t seem to know.

Still, I thought the little one was gaining on me.

There wasn’t anybody around. It was early afternoon and I’d run the only direction I could, toward the Hyatt. Unfortunately, that was through a residential section. Everyone in that area was either at work or occupied within.

I entered the Hyatt proper and weaved past a room service attendant pushing somebody’s late lunch. There was a crash behind me. I looked over my shoulder. The little one was down, waiter and food scattered. The big one sailed over the whole mess and kept coming.

I reached the railed walkway that ran along the side of the Hyatt opening on Central Park. At that point it was one hundred and seventy meters to the parkland

below. I ducked left, checked that I was hidden from my chaser's sight, and dove over the edge.

I dropped sideways, tangential to the walkway, at a little under ten meters per second, the rotational velocity of level ten. Above and to the side of me, I heard footsteps go pounding past, apparently missing my impromptu exit. I fell, moving down in what would look like a looping spiral around the central axis if viewed from the park below.

Earth tourists are particularly nervous when they see someone go over the edge, but they don't realize that in a spinning structure like Belt City, gravity is only *apparent*. Once I left the walkway, the only force working to increase my velocity was wind as I dropped into areas of faster-moving air.

It took me fifteen seconds to reach the slides, and my velocity had only increased by seven meters per second by the time I got there.

The slides are stainless steel concave slopes, polished, running from thirty meters up the base of the walls to forty meters out from the wall. They are primarily a recreational device and secondarily a safety feature.

I tucked my bare forearms and feet out of the way and made contact with my back and the seat of my pants. My vertical speed was not that much of a problem, but I seemed to be skimming over the surface of the slide over twenty meters per second *sideways*. In actuality, it was the slide slipping past at a rotational velocity thirty meters per sec faster than the level I'd left. I had a lot of velocity to make up.

I fetched up at the bottom of the slide with my pants and back warm from the friction. When park diving is done recreationally, one wears a helmet and a neck-to-toe padded coverall. You tend to lose less skin that way.

I headed for the nearest exit.

I phoned Martha from a public phone and said, "Don't say it, but you know what sort of plants my grandmother grows?"

She started to open her mouth, stopped, and nodded. "Sure."

"Key on that word."

I switched over to scrambler and punched in BONSAI. The screen showed garbage for the next thirty seconds. I was about to switch back, sure she'd misunderstood me, when it synchronized and cleared.

"Sorry, I had to look up the spelling," Martha explained. "I thought you were coming by?"

"I did, I was, I didn't. Those two guys you told me about tried to take me for a walk, maybe out a maintenance lock on the rim, but I didn't let it get that far. I'd just as soon not go near your place right now, because that's where they picked me up the first time."

She stared at me, with her mouth slightly open. Finally, she closed it and said, "Oh."

"Could you go get a package for me from Grandmother? She knows you're coming."

She looked pained. "Is it important? I mean, my second-shift manager took a day of anxiety leave and I'm short-handed."

I sighed. "Okay. I understand. You're scared of the man Vaslov has stationed outside Grandmother's and also of these two jokers with the knives. I can find someone else." I pretended to reach for the cutoff switch.

She brought her hand up. "You son of a bitch! Where do I meet you?"

I grinned. "At a maintenance lock, on the rim." I told her which one and her eyes widened. "And, Martha," I said, dropping the smile, "I owe you."

"You sure the hell do," she growled and switched off.

The retailer of vacuum gear I'd talked to earlier was true to his word. I picked up a bag of equipment from him, stopped by a florist, and then went to the public library to borrow a computer.

The calculations came out the same using three different algorithms. I was satisfied. I compiled a list of windows and left in a hurry.

"Where have you been?" Martha said, as I panted up to her in the full gravity of level fifty. "I've been here ten minutes." She looked around her and shuddered slightly. "My feet hurt and it's spooky here."

I nodded and grinned. "That's what people say. It'll keep us from being interrupted." The cover plate to the lock control circuit came off with the aid of an allen wrench. I jumped two wires and pulled another one off its terminal post.

"What are you doing?"

I pushed a button. The inner door opened. "Normally, to open one of these locks, maintenance control pushes a button at the same time. I bypassed that, plus the line that tells them this lock is open." I took my jumpers out and closed the panel again, leaving the one wire disconnected.

"You look like you've done it before."

I smiled. "Once a year, Martha, since I was sixteen. Just early this time, I guess."

She helped me move the equipment into the lock. "You know that tape of those two characters?" I asked her while I stripped to underwear and started putting on my skin suit.

She helped me get the suit straight. "Yeah, what about it?"

"Get it to Grandmother and tell her that they tried to get me."

"Okay."

When she tried to hand me my aluminum oxygen tanks I held up my hand.

"Sorry, Grandmother didn't need to send those. I made other arrangements." I opened the bag I'd gotten from the retailer and took out another set of tanks—bigger and more oblong. "Spun fiberglass—radar transparent."

I connected them and pulled on my insulative cover-all. The skin suit, with its open-weave mesh, would handle any cooling problems, but this far from the sun, the problem was usually keeping warm. Next, I connected a fiberglass hydrogen peroxide tank with catalytic nozzle and controls to my belt by a short line. All in all,



there was less than two kilos of metal in my equipment, including electronics.

"Hand me that box, would you?"

Martha handed me a cardboard container. I opened it clumsily with suit gloves and took from it a white rose. I handed the box back to her and tucked the rose stem beneath a velcro seal flap on my coverall.

"For mother," I said.

She nodded, stepped forward, kissed me gently on the mouth, and helped me seal my helmet. Then she gathered up the bags, box, and tanks and pulled them outside the lock. I pushed a button and the inner door closed.

Pumps whined and it became easier to inhale than exhale. The amber light came on and I opened the outer lock.

I still had to walk down a flight of stairs in vacuum to reach one of the exterior monorail stations. Repairs on the exterior of Belt City are difficult, since it takes a major catastrophe to get the City Council to order spin stopped. So rails run along the outside skin for monorail cranes and work stations, enabling work crews to reach anywhere on the exterior despite the greater-than-one-gee acceleration.

I found myself standing on a balcony of steel grating, able to look down through the holes at the stars spinning by. Looking "south", I could see the mirrors floating kilometers away, by the smelter. Off to one side, a thin silver pencil hung in space—the Slingshot Mass Driver, three kilometers long.

A tiny disk of sun set and rose twice a minute.

Guardrails surrounded the platform except where the monorail passed it. There, chain was stretched across a gap. There was no crane or work station at this lock. They were kept near the center, and this lock was near the North End. "Overhead" was the city, curving out of sight to my right and to my left, and stretching seven hundred meters ahead of me and fifty behind.

First things first. I walked to the railing, unvelcroed

the rose, and dropped it. It sailed away on a curving path, a bright white speck soon lost in the black.

After a few minutes I looked at the chronometer in my helmet. I had four minutes to my first window.

One hundred meters of rope came out of a coverall pocket. I snapped it to the railing and tossed it over the side. It sailed out in a curve, but soon straightened, hanging straight "down". I threaded the top end through brake cars clipped to my belt and climbed over, struggling with the hydrogen peroxide tank. It took me thirty seconds to reach the end of the rope, infinitesimally slowing Belt City's rotation in the process. The chronometer said I had one minute and forty seconds left.

The hundred seconds seemed to last forever. I was hanging by my belt with an apparent gravity of one and a half gee. My back was arched uncomfortably and my blood seemed to be pooling in my head and feet—throb, throb. I took a small pair of wire cutters from a pocket and set them against the rope.

The chronometer reached zero—*snip*—and I was falling.

My velocity relative to Belt City was on the order of sixty-nine meters per second, or about two hundred and fifty kilometers per hour. I had sufficient oxygen and CO<sub>2</sub> scrubber for fifteen hours. If Rowan/Oakley kept on her current course with her last known velocity, I would catch her in one hour and forty-seven minutes. And since there weren't any registered bodies or installations in this direction for over six hundred kilometers, I was pretty sure I'd catch up with her before she got where she was going.

I fiddled with the radio, switching to transponder frequency and cutting in the directional antenna. I set my helmet sextant at a simple one-eighty and wiggled around until Belt City was squarely in the bullseye on the mirror. Faintly, I got the electronic warble I was looking for. The LCD display above my forehead showed me the letters "NZ183." The *Black Orchid* was still on course.

For a while, I listened in on Traffic Control, checking to see if anyone had noticed my exit. My coverall was matte black, with as low an albedo as possible, and I seriously doubted that normal radar would pick me up. I was right. Nobody noticed. Nobody cared whether I'd died or moved to El Paso . . . or something like that.

I went to sleep.

*Beep, beep, beep.*

I was dry-mouthed and groggy. The alarm was going off. I told it to shut up and tried to roll over on my stomach.

*Beep, beep, beep.*

The alarm didn't shut off, and rolling over supposes that one direction is *down*. I came to complete wakefulness and checked the time. I'd been asleep for one hour and fifteen minutes. I shut off the alarm and took a swig of water from the nipple to get rid of the cotton mouth.

Per calculations, Rowan/Oakley should be fifty-seven kilometers ahead of me. Belt City was a bright speck three hundred and fifteen kilometers behind. I did a transponder check to see if *Black Orchid* was still in the right direction. She wasn't. I started checking in a circle around her estimated position and got her transponder fifteen degrees off. I started scanning visually and spent five minutes trying to decide which of the three stars ahead of me were her.

She was the one on the right.

I started deceleration thirty minutes later, grabbing the handle of the hydrogen peroxide tank and lining it up with Belt City, plus a fifteen-degree offset to pull me back to *Black Orchid's* course. Steam, turning almost immediately to ice crystals, blasted out of the two nozzles by the grip at a forty-five degree angle to my suddenly strained arm. I kept this up for twelve seconds before I released the trigger.

When I turned around again, I decided she was within range of my suit's laser ranging system. *Black Orchid* was now three thousand and twenty-two meters

in front of me with a relative velocity of -0.32 meters per sec. Her main viewport was still pointed away from me, but Rowan/Oakley could have a check port or a camera pointed my way.

I wasn't worried. At three kilometers I was just another black piece of space.

We passed within five kilometers of several 500- to 1,000-meter-diameter rocks. Ordinary asteroids probably, since they were this close to Belt City and unprocessed. I was getting hungry—I hadn't eaten since breakfast, seven hours earlier.

She turned the ship three incredibly long hours later. Belt City was almost a thousand kilometers behind us. A few minutes later, she began decelerating.

Things got tricky for a while. She was slowing over a prolonged period of time. If I just sat there, I would soon zip past or run into her. I wanted to keep the comfortable gap I had, but my motor didn't push me at fourteen micro-gees—it was more like two hundred and fifty micro-gees. So, I would give a one-second burst every time our relative velocity exceeded two and a half meters per second, correcting lateral errors as best I could. Graphed, my path would be a wavy line wandering over the straight line of her course.

We seemed to be matching velocities with an installation of some kind. When *Black Orchid* began decelerating, I'd noticed a large kilometer plus diameter asteroid almost dead ahead. It was equipped with a transponder broadcasting the registration code "SS453." With that "SS," I didn't need a *Registry* to tell me it was a scientific station.

I gave myself an added vector—ninety degrees to my course—enough to pass the asteroid on the side opposite *Black Orchid*. I killed the rest of my relative velocity a few minutes later and nudged myself into the rock.

SS453 looked like carbonaceous chondrite—dark brown, low albedo, high in nickel iron ore—but I was ready to swear that it wasn't. No gravity. None I could detect, and I've been on a lot of rocks. For it to have

the pull it was exhibiting, it would have to be incredibly light ore, strewn with pockets.

I scrambled around the horizon, kicking off in tangential leaps and using the HO thruster to bring me back into the surface. I came within sight of the installation on the dark side and hid behind an outcropping.

I was wrong—SS453 was chondrite. It was also hollow.

In the dim light of stars and the ship's own exterior lights, *Black Orchid* was being warped into a hole fifty meters across by two space-suited figures. To one side of the hole, a parabolic antenna, over twenty meters in diameter, pointed into space. Beside it was a heavy-duty communications laser, as large as any I'd seen. It was pointed a different direction. Cables from both ran across the rock and down into the hole.

I flipped through the suit channels, searching for some communication, but couldn't get anything. They were either maintaining radio silence or using a non-standard channel.

The ship and figures dropped from sight. I stayed where I was for ten more minutes, then followed.

It was dark inside.

The hole faced away from the sun and SS453 didn't rotate—otherwise they would have floated their antenna and used some sort of relay. I found a rigged line and pulled myself four meters down into the asteroid, where I stopped.

As my eyes adjusted, I glanced at the communications laser where it was outlined by stars, then at the stars themselves. Ursa Minor and Polaris—what was that laser doing pointing above the plane of the ecliptic? Maybe it wasn't being used and that was a convenient direction—or maybe the rock did rotate and that used to be the right attitude. I pulled myself on into the asteroid.

In the early days, when the crushers couldn't handle the rocks they do today, they'd mine the large rocks inside out. It made sense—when you blasted you wanted the rubble to hang around, not go flying through space and incidental humans. Later, they just picked the

right size rocks and crushed them whole. SS453 was obviously a holdover from those days.

I took some random rangings with the suit laser. There was enough volume within SS453 to hold Belt City. I spotted a lighted lock door set in the side of the hole, then a larger lighted port, and froze against the rock. Spacesuit lights came around a corner where the hole intersected the interior surface and moved up the far side of the hole to the lock. There were three of them—Rowan/Oakley and the two who'd docked her. They cycled through the lock while I thought dark, cold, ancient thoughts, suitable to a slab of chondrite.

It worked; they didn't see me.

I moved into the interior, around the corner, and turned on my lights.

Grandmother was going to be pleased.

"Ahoy, SS453."

I floated on the "day" side of the asteroid, away from their laser, but still in line of sight for one of their ordinary radio antennae. I wondered what they were doing inside? Probably checking their radar screens and looking for a transponder transmission.

"Ahoy, SS453."

They could always send some men out, but they'd have to figure I was nearby and I'd turned my gain way down.

"This is Scientific Station SS453," said a cautious male voice. "Who's calling?"

I grinned. Their proper response should have been to chew me out for improper radio procedure. More proof.

"Boo Bailey, here. Please connect me with Ms. Oakley, also known as Darlene Birch, also known as Linda Maples, also known as Roberta Ash, also known as Jean Rowan."

There was a moment's silence on the other end.

"Excuse me, but you're not making a lot of sense. None of those persons are aboard this station."

"Strange. Registered space vessel NZ183, carrying

Ms. Oakley, was moved into your asteroid's interior twenty-three minutes ago."

There was no hesitation; the person on the other end was good. "Oh, really? If that's the case, it's not something I'm aware of."

"Maybe you should talk to your boss. Maybe somebody's not telling you something."

"My name is Dr. William Reese. I *am* in charge of this installation."

I hesitated for a moment. Could he be completely unaware of what was going on? I decided not. "My mistake, Doctor. I'll just turn the matter over to ISRC Security and the U.N. Civil Police. Sorry to bother you."

"Why should the police be interested?" he got that question in quick, before I could even pretend to sign off.

"Well, I could talk about missing equipment, raw materials, even computer tampering, but the cutest one is several thousand cubic meters of sewage. Dr. Reese, you have enough equipment and materials in that asteroid to build an O'Neal colony. I'm amazed. You must have been acquiring supplies for the last decade."

I recognized Rowan/Oakley's voice from her exchange with traffic control when she'd left Belt City.

"Stop. Please don't transmit anything else. We're on open frequencies."

I nodded at that. It was unlikely that anyone had picked up my weakened transmission, but to tell them that would tell them where I was. "I can scramble," I said. "Key in the place you worked as Jean Rowan, okay?"

"Initials or full name?"

"Initials."

I keyed in EIC for Equipment Inventory Control, and waited until I heard her say, "Can you read me?"

"Yes."

Over the radio came a deep, tired sigh. "Okay . . . what do you want?"

"I want you to talk to my grandmother."

"Your grandmother is . . . ?" I couldn't decide whether she was faking or not.

"Anita Moss."

"You don't mean the systems expert?" She sounded excited at the prospect. "The person who wrote FASKAN Relational Filing?"

"Yes—that was one of hers."

Her voice became wary again. "Why does she want to talk to me?"

I grinned. "Wrong. The question is why do you want to talk to her? The answer is, you'd rather talk to her than Captain Vaslov of the uncivil police. In one of their boats, he could be there in ten minutes."

"I must confer with my colleagues."

"Confer away. I'm not going anywhere."

I would've loved to have had a bug in that room. She was back in five minutes. "Okay, I'll call her. Do you have a scrambler reference?"

"Wrong again. You'll go see her in person—now—at highest possible acceleration. This business will *not* be transacted by phone."

"But my work . . . !" She paused, then said tiredly, "As you said, I don't have much choice. I'll leave in ten minutes."

"A real pleasure talking with you. Bye."

*Came a rapping, came a tapping. . . .*

She'd been accelerating for five minutes when I matched velocities and dropped onto her main port. I must've scared her to death.

"Who the hell are you?" she said over standard hailing frequencies.

"Boo Bailey, again. Look, could you let me in? I've been in this suit for seven hours and I need a *bathroom*." I didn't mention that I didn't have the reaction mass to get back to Belt City before my life support was depleted.

I made her run her tanks dry on the way back. With constant acceleration, the trip took an hour and thirty-



three minutes. I didn't say much to her except to ask what name she preferred.

"Mary," she told me. "Mary Oakley."

The rest of the time I spent making sure she didn't kill me.

Not that she tried, but she and her "colleagues" were the best suspects I had for Evans' murder. I watched her carefully.

Lock control was funny.

I went through the line close behind her, answering the standard questions. "No, I have not been in contact with nonquarantined humans. No, I am not carrying any pharmaceuticals, prescription or otherwise." Then I stuck my face up to the retina scanner to see if I was a registered criminal.

Confusion. "Uh, there's an egress prohibition linked with your record."

I nodded. "Right."

"You're not allowed to leave the city."

"Right."

"According to our records, you haven't been outside the city in two months."

"Look—what's the problem? I'm not leaving. I'm entering. Do I have an entrance prohibition on my record?"

"Uh, no."

"Why worry about it?"

"Uh, right." He waved me on, but I saw him turn to the phone as we left.

Grandmother was relieved to see me.

It wasn't obvious—not to anyone who didn't know her, but when she saw me enter the office, she actually *smiled*.

"Mary Oakley, this is Anita Moss." I escorted her to the web chair, the same one Evans sat in for the last time thirty-six hours before. She sat carefully, apparently composed, but I noticed her fingers were white where she clamped onto the edge of the chair.

"How do you do?" asked Grandmother.

"Uh, fine."

Grandmother sat back and looked from Oakley to me. I was tired, grumpy, and still keyed up from watching Oakley.

I said, "About a third of your missing equipment and supplies are sitting inside a hollow asteroid masquerading as scientific station SS453. It's one thousand kilometers up orbit."

Oakley snapped, "It's a legitimate scientific station! We do work on closed-system ecologies and zero-gravity calcium loss."

"Do you also work with the Search for Extra-Terrestrial Intelligence?" I asked.

She looked wary. "No, we have nothing to do with SETI."

Grandmother narrowed her eyes. "Why do you ask, Boo?"

"They have a heavy-duty communications laser pointed toward Polaris and a twenty-meter parabolic antenna pointed somewhere else. I don't see what that sort of communications equipment has to do with closed-system ecologies or zero-gravity calcium leaching, especially when they can route stuff through the facilities here at Belt City."

Grandmother turned back to Oakley. "Well, Ms. Oakley?"

"What has that got to do with anything? What do you want? Why did you have this juvenile megalomaniac blackmail me into coming here?"

I raised my eyebrows. Grandmother blinked and looked at me.

"Well, I *did* suggest that we would rather talk to you than Vaslov or Derekin. Is that not the case?" I asked, turning back to Oakley.

She leaned back in her chair and looked defeated. "I suppose so."

Grandmother leaned forward. "Does that mean you're willing to answer my questions?"

Oakley crossed her arms. "To what end? What are

you trying to find out? Are you working for yourself or are you representing the ISRC?"

Grandmother frowned, but answered her. "I am representing myself. I *was* investigating the theft or sabotage of ISRC equipment over the past thirty years, but that commission, if it ever existed, has been repudiated by the ISRC. I am currently investigating the murder of Percival Evans."

I'd been waiting for this moment. It's one reason I didn't mention the murder on the radio—I wanted to *see* her reaction.

She frowned. "Who?"

"Percival Evans—special assistant to the High Commissioner. He was poisoned approximately twenty-four hours ago."

Oakley cocked her head to one side and closed one eye. "Look, you have me at a disadvantage. You know about items in our possession that we have no legal claim to—though I can make a case for a moral claim. Regardless, you could have me punished and imprisoned for theft, fraud, and, I suppose, embezzlement. But you've got to believe me—I don't know anything about murder!"

"Where were you last night at 2130?"

Oakley thought for a moment. "I was eating supper with Dr. Rory Herzig, at the Hilton."

"Dr. Herzig, the physicist? From the Deep Space Institute?" Grandmother asked.

"Yes. He corresponds with Dr. Reese on various projects."

"Did you eat in the public dining room?"

"Yes."

Grandmother pursed her lips. "How many people know of the existence of your stockpile of materials and equipment?"

Oakley uncrossed her arms and clamped her mouth shut.

"Come now, Ms. Oakley. I haven't asked you to name names. I just want to know how many people might have killed Mr. Evans."

"Why would we have killed him?"

"If Mr. Evans' investigation was successful—and you see that it was—he would have uncovered your illegal stockpile. Killing him, and perhaps me as well, would've hindered such an investigation."

"So? If you started digging, do you know how many such activities you'd uncover?"

Grandmother nodded. "I've considered that. Before my access to the Commission Network was cut, I'd noticed some tampering that didn't have your fingerprints." She steepled her fingers. "You said something earlier, about having a moral claim to that equipment. I'm curious as to what that might be."

Oakley sat still for thirty seconds, staring at Grandmother, brow wrinkled. Finally she said, "One of the reasons I agreed to talk to you was your reputation. Dr. Reese claims that you resigned your Commission seat because you were fed up with the corruption—the graft."

Grandmother frowned. "I'm not that lily-white, but that was part of it."

Oakley nodded. "But you still have that reputation for integrity."

"Get on with it," Grandmother said irritably.

"We're stockpiling that equipment to create an independent colony. We want to keep it from being wasted and stolen by greedy bastards—twits who don't give a damn about keeping us out here."

Grandmother waved a hand. "So it's altruistic, eh?"

"Hell, no!" said Oakley. "We want to make money, too, but we also want to stay out here. This is our home."

I felt something curious when she said that—a tingling around my stomach and in the cheeks. I asked her, "How long do you think you'll last—even with your equipment—once the ISRC finds out? They'll keep your ore from reaching Earth and the things you'll need from Earth from reaching you. You have to go through them."

Oakley started to say something, then stopped. In-

stead she said, "We'll manage. After all, the charter comes up for renewal in twelve years. It won't pass."

"Twelve years is a long time to wait," Grandmother said. "Especially if you don't have the equipment and are in prison."

Oakley looked at the floor. "I guess I didn't sell you."

"You are ambitious and idealistic. I have no qualms about your *stated* objective—I just don't know how much is acting and how much is conviction. I will make a deal with you," said Grandmother, leaning forward. "If you and yours turn out to have nothing to do with the death of Percival Evans, I will keep to myself any knowledge of your unorthodox acquisitions. In return, you'll acquaint me with as many of the *other* parties engaged in embezzlement and theft of ISRC materials as you've run across in your own activities."

Oakley looked up again, eyes alive again. "Agreed."

I scratched my head and looked at Grandmother. "I hope you know what you're doing."

Vaslov showed up fifteen minutes later. I checked him on the door monitor and told Grandmother, "Vaslov—alone."

Oakley had been answering a steady stream of questions while I'd showered and changed. Now she almost lost it. "Is he here for me?" her eyes were wide, staring at Grandmother.

I shook my head and looked at the ceiling.

"No, Ms. Oakley. He is here to harass Boo and me. I imagine he heard about Boo's entry into the city and now wants to know where he's been—among other things."

The doorbell rang again.

"If you would wait in the kit . . . exercise room while we take care of this, you can avoid him entirely."

I showed her the room on my way to the door and waited until that door was closed before I let Vaslov in.

"Captain Vaslov," I said, nodding.

His eyes narrowed and he walked past me without a word. I shrugged, shut the door, and followed. Before I

entered the office again, I locked the door to the kitchen. Grandmother may have been working on the hypothesis that Oakley wasn't the murderer, but I noticed she was avoiding an opportunity to be poisoned again.

Vaslov was getting excited in the office.

"You are in the jurisdiction of the U.N. You can be deported!"

Grandmother smiled. "Perhaps you could get me deported—I am a citizen of the United States of America. But Boo's a citizen of the U.N. He was born here. You couldn't deport him."

"I can *imprison* him," said Vaslov.

Grandmother shook her head. "For what? This is not the Soviet Union, Captain."

Vaslov whirled around when I entered the room. "Where have you been for the last eight hours?"

I said, "Walking, talking, sleeping, and weeping. Where have *you* been?"

"You see?" he said to Grandmother. "Obstruction of justice!"

"You see?" I asked Grandmother. "Invasion of privacy."

The doorbell rang again.

It was Derekin. I let him in, to get under Vaslov's skin.

"Vaslov," nodded Derekin, as he entered the room.

Vaslov put his arms behind his back, parade rest style, and faced Derekin. I could see his arms shaking from where I stood. "Director Derekin, I wish you'd consulted with me before issuing your press release."

Derekin said, "I've no time for that nonsense, Vaslov. I'm ready to name the murderers—are you interested?"

Vaslov's eyebrows rose. "You are sure of your information?"

"Yes."

"Then I am interested."

"Boo Bailey and Anita Moss, as I thought all along!"

"Damn," I said. "And I thought we were going to get away with it."

Vaslov looked at the ceiling. "I don't suppose you bothered to acquire proof?"

"Damn right, I acquired proof." He pulled a bottle from his pocket. "Your own forensic chemist has identified this as the diamine amino acid analog that killed Evans." He paused for effect. "It was found in *The Johnny-Go-Lightly*, Ms. Moss's personal rock buggy, usually piloted by Boo Bailey."

Grandmother spoiled it by laughing.

Vaslov held out his hand. "Did you look for fingerprints?"

"Of course—it had been wiped." Derekin handed the bottle to Vaslov. "Do you think I'm stupid?"

Vaslov refrained from answering. Instead, he turned to me. "So this is what you were doing outside the city."

"That's right," I said. "In addition, I slipped back to Earth, overthrew three small African nations, and killed Commissioner Rostaprovich." I held out my arms, wrists together. "Take me away, I'm a dangerous man."

Vaslov almost smiled. "Try to be serious. Do you have any constructive comments?"

I looked closer at the bottle. "Glass bottle, plastic lid, right?"

He nodded.

"Why do I store it in the buggy when I can go to the rim, jimmy a lock open, and just let go? It's radar transparent—who'd see it? Gone forever and ever. Or, for that matter, why not just flush it down a toilet? It's a plant. The only question is, did Derekin do it to preserve his cute little theory, or is it a real clue?"

Derekin turned red and I could almost see the pimples forming. "I do not plant evidence!"

Vaslov looked skeptical.

I grinned. "When did you get the message telling you to search the buggy?"

Derekin's mouth dropped open. "How. . . ."

"What good is plant if nobody finds it?"

Grandmother cleared her throat. "Then there's the matter of method. Has it been determined that the poison was put on the lobster after it arrived in the room?"

Vaslov looked at Derekin before saying, "Yes. There were no traces of it in the preparation pans and the dish was filled in the dining room under the supervision of the maitre d'. Both he and the waiter support each other's story and I've questioned them under Clifton multigraph as well."

"I see."

She reached into a drawer. "There are two men shown on this tape. There is reason to believe they are involved in some way with the murder of Percival Evans."

Derekin reached for the tape, but Vaslov beat him to it. "What makes you think this?"

"Because they tried to kidnap me this morning," I said. "And the only thing I got out of them was that 'it was asking questions that got me into this mess in the first place'. They also carry concealed knives. I believe that is a violation of the municipal statutes."

Derekin interrupted. "What bullshit is this? Aren't you going to arrest them, Vaslov?"

Vaslov turned to Derekin. "I suggest you remain quiet as long as you continue to have nothing constructive to say."

I liked his phrasing.

"Please give me the details of this kidnapping."

I gave it to him—short, but complete. He looked at the ceiling for a moment. "Why didn't you report this then?"

"I offer it now in a new spirit of rapprochement."

Vaslov's eyes narrowed.

Grandmother asked, "Have you investigated the availability of the poison?"

Vaslov was talking easier now. "It can be synthesized in a well-equipped laboratory—but it does require some expertise. There are no supplies of the finished product in the belt."

"Have you checked the educational background of all the persons at the dinner to see if one of them had the expertise?"

"*Da*. None of them per their personnel files. We are checking from the other end—looking for people with



the expertise and then trying to link them with the suspects. This is a slow process."

"Assuming Director Derekin did indeed find the poison aboard my ship, check your records to see if one of them went out of North Lock today."

Vaslov nodded. "I had considered that already." Derekin was scowling at the corner of the room. "You still haven't pressed them about what they were investigating."

"That is true. Are you ready to tell me anything?"

"Only what I've said before. We were investigating an unusual trend in equipment loss. Apparently, someone learned of our investigation and was worried about what we would discover."

Vaslov asked, "When do you think they found out about Evans' investigation?"

Grandmother shrugged, then saw me frowning.

"What is it, Boo?"

"Those two men—the ones who tried to grab me? According to a friend of mine, they started looking for me the day before Evans first came to us."

"Well, then," said Grandmother. "If they are involved, then that puts the leak beyond us. Perhaps even on Luna."

Derekin said, "I've got a telex on my desk that says Evans wasn't investigating anything! I say you're creating a smokescreen to hide behind."

Vaslov considered that. "Do you have a response to that?"

"Authorized or not, Evans asked us to begin an investigation. That's all I have to say on the subject."

Vaslov grunted. "I think I will start checking on these things we've discussed," he said, hefting the tape. "I will talk with you later." He started to leave. "By the way, I've left a man outside your door. Please clear any excursions with him." He walked to the office door.

Derekin stood where he was for a second.

Grandmother said, "Goodbye, Captain Vaslov. Goodbye, Director Derekin."

"I'm still not satisfied, Anita," said Derekin, obnoxious to the end.

Grandmother cut in sharply. "It is not required that you be satisfied. This dwelling is not ISRC property. You are invited to leave."

Derekin scowled for a moment, then stormed out, passing Vaslov as if he wasn't there.

After they'd both left I came back and said, "You know, Grandmother, I don't care what we find out. If Derekin didn't kill Evans, we should give serious consideration to framing him."

"Look at this."

I held it out on my palm at arm's length, a small black dot about two millimeters across, with a hair-thin wire antenna.

"My word," said Grandmother.

I took it into the bathroom and flushed it down the toilet.

Grandmother had wanted to bring Mary Oakley back into the room, but I'd insisted on sweeping for bugs first.

When I came back in she was frowning. "Which one left it?"

"It must have been Vaslov. It was on the wrong side of the room to be Derekin or Oakley. Anybody else been here?"

"No."

I prepared supper for Grandmother, Mary Oakley, and myself. We ate in the kitchen while Oakley continued to answer Grandmother's questions.

"Most of the theft is all on paper. Over half of the equipment loss is materials that were never delivered. Various officials "destroy" them on paper and pay the vendors who "supplied" them in the first place. Then, large portions of that payment end up in the officials' New Eden bank accounts."

"When did you start your acquisitions?"

"In '73. I'd been working for ISRC for three years and was starting to see what was going on. My parents

worked for the ISRC and I was mostly raised out here. There were others who felt as I did. We started small and slowly recruited high-quality personnel. Very few of them actually know about the equipment—that was accomplished by a dedicated few acting over a decade."

I swallowed a bite and said, "Then you weren't responsible for changing the original expected-loss figure back in '56."

"How old do you think I am? That was somebody else—it was something I was taking advantage of, though."

"How much of the rest is physical theft?" Grandmother asked.

"We're not sure. At least some of it is. We suspect that a few commissioners are setting up to go private sector with ISRC equipment after the charter is defunct."

"They're taking the long view," I said. "Twelve years is a long time to wait."

Grandmother shook her head. "Twelve years is the blink of an eye." She turned back to Oakley. "So you don't really know actual individuals?"

"Not really."

Grandmother pushed her plate away and wrinkled her brow. I started cleaning up.

Finally Grandmother said, "Thank you, Ms. Oakley. You've been most helpful. I'll keep my promise. Please let Boo know where you can be reached." Then she went back to her office.

When I went to bed three hours later she was at her desk staring at nothing, her fingers steepled and tapping gently against each other.

I wondered what she'd thought of.

Next morning my alarm went off at eight. I didn't remember setting it. I hadn't. There was a note taped to it—a printout of instructions from Grandmother.

I made a call.

Inspector Vaslov said he would be glad to be there at

1330 and would ensure the arrival of another guest. I asked him if he'd had any luck with my kidnappers.

"Yes and no. We have identified the two men in the tape—they arrived from Luna two days before Evans. They are a Mr. William McKeel and a Norren Warwood. What's more, they passed through North Lock control yesterday at 1500 and back in again at 1532."

"Ah."

"On the other hand, they have not been back to their hotel rooms since they checked in three days ago. A search has found no luggage or personal belongings there."

"I see. Which one was which?"

"McKeel was the larger of the two," Vaslov said.

"Excuse me, Captain, but isn't it against U.N. policy to be so cooperative?"

Vaslov didn't blink an eye. "I offer it now in a new spirit of rapprochement." He signed off.

As I fixed breakfast, I couldn't help but think that a cooperative Captain Vaslov was too much to handle.

Grandmother received the telex at 1245, beep, beep, at her computer terminal. She had it print out and read the message to herself. "Good enough," I heard her say. Then she retired to get ready for company. Oakley had left the night before, but was due back later that afternoon.

Vaslov arrived at 1320, early. As I was letting him in, up came Derekin.

"I didn't even talk to him about it," said Vaslov. "I knew he'd be here. One day I will get rid of his spy in my office, but then I will have to phone him myself when I want him somewhere."

Derekin ignored him and walked on into the office. Vaslov followed. I looked out in the hall for Vaslov's man, but he'd apparently been dismissed.

Ann Bogucki arrived three minutes late. I met her at the door. She was breathing fast, balancing a briefcase and a pile of file folders in her arms. "Sorry I'm late. Just came from the Union Contract negotiations." She

looked around, saw the small table next to the front door, and set the whole mess there. "That should keep. Well, what's going on? Why did Captain Vaslov ask me to come here?"

"Beats me," I said honestly. "I'm only the hired help." I showed her into the office and seated her in the web chair. Then I went over and stood by the bonsai.

Grandmother came in seconds later.

"Good afternoon, Ms. Bogucki, Director Derekin, Captain Vaslov."

Assorted returned greetings. Derekin fidgeted in the background, Vaslov stayed still, but watchful, and Bogucki toyed with a small shiny object hanging from her jacket on a clip. It looked like cosmetic air brush.

"How can I help you, Ms. Moss?" asked Anne Bogucki. "I thought that Captain Vaslov had asked all the possible questions."

Grandmother nodded slightly. "That's undoubtedly true. However, he may not have asked them of the right people. I'd like to go over what happened two nights ago, the evening Mr. Evans was killed."

Derekin shook his head angrily. "We've been over that enough already. Is this why we're here?"

Vaslov smiled—sort of. It was a smile that made me glad I wasn't a Soviet citizen. Derekin saw it and shut up.

"As I remember it," Grandmother continued, "Commissioner Hall, Laura LeHew, and you were talking over by the buffet as it was loaded."

Bogucki nodded.

"Laura was snatching things off the trays as they came by, then you sampled the lobster and Commissioner Hall tried the ham. Is that essentially it?"

"We have been over this quite a few times, Ms. Moss," Bogucki said. "What's the point? Any of us could have put the poison in the lobster."

"True. But only one of you had the expertise to make it. What do you know of biochemistry, Ms. Bogucki?"

"What most people know, I suppose."

"Nothing special? No particular *expertise*?"

"No," Bogucki said flatly. She looked calm enough, but she was gripping the object on the clip tight enough to whiten her knuckles.

Grandmother shrugged. "Captain Vaslov, I suggest you arrest Anne Bogucki for the murder of Percival Evans."

Derekin raised his arm in the air. "This is too much! Trying to pin it on Anne isn't going to get you off the hook."

Grandmother lifted the piece of paper off her desk and held it up until Derekin ran down.

"I have here a telex I received one hour ago in answer to one I sent last night. At my request, the Panzer Detective Agency in Manhattan did a quick investigation into Ms. Bogucki's background. Before acquiring her doctorate in business administration, she received a bachelors in biochemistry and worked two years as a research technician for Carroll Pharmaceuticals. For those who don't know, Carroll Pharmaceuticals is the manufacturer of fluoroglobin, the most widely used blood substitute on the market."

Vaslov frowned, swore, "*Chyort vosmoi*, but what about her personnel file? None of that is in her record."

Grandmother smiled. "That's right—but tell me, Captain Vaslov, what is Ms. Bogucki's job?"

Vaslov nodded grimly. "Director of Personnel. It was a small matter to change her own file, wasn't it?"

"Just as important," added Grandmother, "she had access to my old file and Evans' current file. She knew we were fluoroglobin users."

I was watching Bogucki. She was sitting very still, looking straight ahead at Grandmother. Suddenly she sighed.

"Just one thing—how close were you to implicating me in the equipment hoarding?"

Grandmother shrugged. "Not very close. We discovered that the activity was going on, but what you apparently don't realize is that several different groups are engaged in the activity." She paused. "If you hadn't

killed Evans, chances are we never would have found you out."

Derekin looked at Bogucki, eyes large, shocked.

Bogucki looked sad, then pulled the cosmetic air brush off the jacket clip with a sharp little jerk.

The front of the apartment blew up.

*Her briefcase.*

Smoke and dust, following the shockwave, billowed into the room. My ears rang. I blinked dust from my eyes, picked up the nearest plant, and threw it as hard as I could at the door to the office.

Grandmother screamed, "*Not the bamboo!*"

Norren Warwood came through the door and took it, pot first, in the face. His burp gun, set on automatic, carved chunks of plastic out of the ceiling as he went back over.

I kicked off the plant bench hard, knowing how difficult it would be to get any traction in a twentieth of a gee. Halfway to the door I flipped over, feet first.

William McKeel saw me through the doorway and brought his burp gun up. I thought I was dead, but he had to jump over Warwood to avoid tripping and, accustomed to lunar gravity, he jumped too hard. His head bounced off the ceiling and the gun fired off to my left. My right foot connected with his face and I felt his collar bone snap under my left heel.

Rebound took me slightly back into the office, but McKeel had done a wonderful job of absorbing most of my momentum. He bounced off the hall wall. I scrambled for their burp guns and backed off quickly, but they weren't moving.

I became aware of someone screaming.

It was Derekin—he'd taken a stray bullet in the thigh. Grandmother was trying to lay him down so she could put a compress on the wound. Vaslov was standing over Bogucki's chair, a strange expression on his face. I wondered why she just sat there, looked closer, and vomited.

A large percentage of her head was missing.

\* \* \*

Mary Oakley rang the bell to the hotel suite early that evening. We were in the president's suite of the Hilton, at even lower gee than the apartment. Still sweating from moving the last of the bonsai, I opened the door and showed her where Grandmother was still fiddling with the grow lights, trying to get them just so.

"Growing bonsai in this gravity is a tricky situation, Mary. In low gravity, plants have a tendency to explode into growth, not having to allocate much of their production to support structures. Bonsai are mostly support structure, gnarled twisted trunks and branches—thick where the low gee tendency is to be thin." She paused and decided they were finally getting enough light. "An analogy could be made for human expansion in space. The ISRC is like me, making twisted, thick organizational structures when we could be growing like thin vines through the belt."

Oakley nodded to be polite. Grandmother moved over to a chair and sat. I sat myself, by the door to the room, still nervous. Grandmother was still mad at me.

"Oh, well. Thanks to you and your colleagues, the days of the ISRC are numbered."

Mary Oakley blinked. "Us? Why give us the credit?"

"Because you built the visitor. When did you launch it? No, wait—it was summer of '66, wasn't it?"

Oakley looked flustered. "What are you talking about?"

"What does it matter, Mary? If you want to claim otherwise, that's your right, but '66 would have been right for an orbital assist from Jupiter. Your vehicle did a gravity well maneuver to throw it up above the plane of the ecliptic, then fell back in toward the sun for the next ten years. Nice touch."

Mary frowned, looked around the room.

My mouth dropped open. "So that's what you were doing with that laser. You were listening in on the broadcasts from Earth to the probe and then telling the probe what to respond with a tight laser beam so nobody could hear. It was nothing but a fancy relay station!"

Oakley stopped frowning and smiled slightly. "Don't be ridiculous."



Grandmother went on as if she hadn't heard. "It doesn't matter now. You've got your agreement with Earth. They may be a little upset when they find you're human, but I'll bet they honor it. They're looking for any way to get around the ISRC Charter. You'll be a handy means."

Oakley smiled even more when she said, "If we were behind the probe, what you say would undoubtedly be true, but naturally, the Republic of Kepler would never engage in such a fraud."

Grandmother looked at her for a moment, smiled, and said, "Of course."

I looked from Grandmother to Oakley and back again. "Nuts," I muttered.

Grandmother then said, "It would be nice to know when the Republic of Kepler gets around to accepting applications for citizenship."

"Somehow," Oakley said, "I think you'll be the first to know."

"So why did it have to be the bamboo, Boo?"

It had finally come out. She wasn't going to sulk anymore, but confront me with it.

"Why do you think? It was because I knew it was your pride and joy—your favorite plant. Why pick something else when I can save your life and break your heart at the same time?"

She opened her mouth, closed it, opened it again. "You could have given me heart failure!"

"How long did it take you to train that plant?"

Her eyes narrowed, went steely on me. "Fifteen years."

I grinned. "Then I knew you had at least fifteen more to live. That's how long it will take you to do it again and *you* won't die until you do." I tilted my head. "Honestly, Grandmother, did you think I did it on purpose? I just grabbed the first one I could and threw it. If they'd made it into the room they would have killed all of us, wounded Bogucki to give her an alibi, and run. We'd be dead, Bogucki would be alive, and

Vaslov wouldn't be on his way back to Luna with sixteen arrest warrants."

She leaned back, closed her eyes, and rubbed at her temples with parchment-covered fingers. "Oh, I suppose you're right. But fifteen *years* . . .!"

I sighed. "Are you done with me?"

"I suppose. What are you going to do now?"

I smiled and strode to the door. "I've an appointment with Martha Goodwin . . . something about cultural biology."

*The ship was approaching high Earth orbit when it made its first transmission. This consisted of the query symbol followed by a tentative recognition symbol. When excited operators acknowledged the transmission, the ship returned with a verbatim repeat of the Agreement of Intent negotiated by the probe. The next transmission from Earth invited more effort toward refining their shared language. The ship's reply was in English.*

*"Don't bother. It's an interesting language, but we can probably get along better in this one. We are open for video transmission."*

*Screens were switched on and voices raised in outrage. "What sort of hoax are you trying to perpetrate? You aren't aliens!"*

*A human stared back from the screen. "I could dispute that, but it's not important. What is important is that we're the builders of the visitor."*

*"Impossible. The visitor entered our system from the direction of the head of Draco. Mankind hasn't strayed from the plane of the ecliptic."*

*"Let me show you something," said the human.*

*He flicked a switch and his image vanished off the screen to be replaced by a recorded film. The image in the screen now was the slingshot. A voice was talking. "In September of 2066 the remote probe known as the visitor was launched from the ISRC belt operations mass driver out of the system, specifically at a rendezvous with Jupiter." The screen changed to an animated plot of the solar system, showing the visitor's path*

outbound from the asteroid belt. "Upon reaching the close proximity of Jupiter, the probe was directed into a gravity well maneuver." The dotted line dipped abruptly below Jupiter and came up at over ninety degrees off its original course. The dotted line started climbing high above the plane of the ecliptic. "As you can see, the visitor was in orbit for over twelve years before it made itself visible to the observatories of the system." A bright line appeared between a spot in the asteroid belt and the probe. "The visitor was controlled by laser link from the capital of the Republic of Kepler, Independence." The screen switched to the exterior of Independence, once known as Scientific Station SS453. "Once the trade agreement was negotiated, the probe was given the command to self-destruct. This was by means of a small chemical explosion too small for visual identification. The resultant debris should re-enter the inner system in another seventeen years."

The man's image appeared back on the screen. "I have on board this ship twenty metric tons of Praseodymium, which I am willing to trade to the highest bidder. I don't have to tell all the uses for this rare earth. We will await offers on this frequency."

"But wait a minute, even if you did build the probe, you aren't extraterrestrial. You're from Earth! The agreement is void!"

"The agreement says nothing about planet of origin, and even if it did, I wasn't born on Earth and I have never, I repeat never, been on Earth in my life. If that isn't extraterrestrial, then I don't know what is." He switched off.

"Do you think it will work?" he asked his wife.

The woman smiled. "Of course it will. Even if we didn't fit the exact wording of the agreement, they'd find some excuse. They've had to bear the ISRC for too long. I'm just wondering how they'll word it in the papers."

The man stretched back and locked his fingers behind his neck. "Oh, that's simple. Another 'first contact' story."



*Here is an excerpt from the new novel by Timothy Zahn, coming from Baen Books in August 1987:*

# TIMOTHY ZAHN

## TRIPLET

The way house had been quiet for over an hour by the time Karyx's moon rose that night, its fingernail-clipping crescent adding only token assistance to the dim starlight already illuminating the grounds. Sitting on the mansion's garret-floor widow's walk, his back against the door, Ravagin watched the moon drift above the trees to the east and listened to the silence of the night. And tried to decide what in blazes he was going to do.

There actually *were* precedents for this kind of situation: loose precedents, to be sure, and hushed up like crazy by the people upstairs in the Crosspoint Building, but precedents nonetheless. Every so often a Courier and his group would have such a mutual falling out that continuing on together was out of the question . . . and when that happened the Courier would often simply give notice and quit, leaving the responsibility for getting the party back to Threshold in the hands of the nearest way house staff. Triplet management ground their collective teeth when it happened, but they'd long ago come to the reluctant conclusion that clients were better off alone than with a Courier who no longer gave a damn about their safety.

And Ravagin wouldn't even have to endure the

usual froth-mouthed lecture that would be waiting when he got back. He was finished with the Corps, and those who'd bent his fingers into taking this trip had only themselves to blame for the results. He could leave a note with Melentha, grab a horse, and be at the Cairn Mounds well before daylight. By the time Danae had finished sputtering, he'd have alerted the way house master in Feymar Protectorate on Shamsheer and be on a sky-plane over the Ordarl Mountains . . . and by the time she made it back through to Threshold and screamed for vengeance, he'd have picked up his last paychit, said bye-and-luck to Corah, and boarded a starship for points unknown. Ravagin, the great veteran Courier, actually deserting a client. Genuinely one for the record books.

Yes. He would do it. He would. Right now. He'd get up, go downstairs, and get the hell out of here.

Standing up, he gazed out at the moon . . . and slammed his fist in impotent fury on the low railing in front of him.

He couldn't do it.

"Damn," he muttered under his breath, clenching his jaw hard enough to hurt. "Damn, damn, *damn*."

He hit the railing again and inhaled deeply, exhaling in a hissing sigh of anger and resignation. He couldn't do it. No matter what the justification—no matter that the punishment would be light or nonexistent—no matter even that others had done it without lasting stigma. He was a *professional*, damn it, and it was his job to stay with his clients no matter what happened.

Danae had wounded his pride. Deserting her, unfortunately, would hurt it far more deeply than she ever could.

In other words, a classic no-win situation. With him on the short end.

And it left him just two alternatives: continue his silent treatment toward Danae for the rest of the trip, or work through his anger enough to at least get

back on civil terms with her. At the moment, neither choice was especially attractive.

Out in the grounds, a flicker of green caught his eye. He looked down, frowning, trying to locate the source. Nothing was moving; nothing seemed out of place. Could there be something skulking in the clumps of trees, or perhaps even the shadows thrown by the bushes?

Or could something have tried to break through the post line?

Nothing was visible near the section of post line he could see. Cautiously, he began easing his way around the widow's walk, muttering a spirit-protection spell just to be on the safe side.

Still nothing. He'd reached the front of the house and was starting to continue past when a movement through the gap in the tree hedge across the grounds to the south caught his attention. He peered toward it . . . and a few seconds later it was repeated further east.

A horseman on the road toward Besak, most likely . . . except that Besak had long since been sealed up for the night by the village lar. And Karyx was not a place to casually indulge in nighttime travel. Whoever it was, he was either on an errand of dire emergency or else—

Or else hurrying away from an aborted attempt to break in?

Ravagin pursed his lips. "*Haklarast*," he said. It was at least worth checking out.

The glow-fire of the sprite appeared before him. "I am here, as you summoned," it squeaked.

"There's a horse and human traveling on the road toward Besak just south of here," he told it. "Go to the human and ask why he rides so late. Return to me with his answer."

The sprite flared and was gone. Ravagin watched it dart off across the darkened landscape and then, for lack of anything better to do while he waited,

continued his long-range inspection of the post line. Again he found nothing; and he was coming around to the front of the house again when the sprite returned. "What answer?" he asked it.

"None. The human is not awake."

"Are you sure?" Ravagin asked, frowning. He'd once learned the hard way about the hazards of sleeping on horseback—most Karyx natives weren't stupid enough to try it. "Really asleep, not injured?"

"I do not know."

Of course it wouldn't—spirits didn't see the world the way humans did. "Well . . . is he riding alone, or is there a spirit with him protecting him from falls?"

"There is a djinn present, though it is not keeping the human from falling. There is no danger of that."

And with a djinn along to— "What do you mean? Why isn't he going to fall?"

"The human is upright, in full control of the animal—"

"Wait a second," Ravagin cut it off. "You just told me he was asleep. How can he be controlling the horse?"

"The human is asleep," the sprite repeated, and Ravagin thought he could detect a touch of vexation in the squeaky voice. "It is in control of its animal."

"That's impossible," Ravagin growled. "He'd have to be—"

*Sleepwalking.*

"Damn!" he snarled, eyes darting toward the place where the rider had vanished, thoughts skidding with shock, chagrin, and a full-bellied rush of fear. *Danae—*

His mental wheels caught. "Follow the rider," he ordered the sprite. "Stay back where you won't be spotted by any other humans, but don't let her out of your sight. First give me your name, so I can locate you later. Come on, give—I haven't got time for games."

"I am Psskapsst," the sprite said reluctantly.

"Psskapsst, right. Now get after it—and *don't* communicate with that djinn."



The glow-fire flared and skittered off. Racing along the widow's walk, Ravagin reached the door and hurried inside. Danae's room was two flights down, on the second floor; on a hunch, he stopped first on the third floor and let himself into Melentha's sanctum.

The place had made Ravagin's skin crawl even with good lighting, and the dark shadows stretching around the room now didn't improve it a bit. Shivering reflexively, he stepped carefully around the central pentagram and over to the table where Melentha had put the bow and Coven robe when she'd finished her spirit search.

The robe was gone.

Swearing under his breath, he turned and hurried back to the door—and nearly ran into Melentha as she suddenly appeared outside in the hallway. "What are you doing in there?" she demanded, holding her robe closed with one hand and clutching a glowing dagger in the other.

"The Coven robe's gone," he told her, "and I think Danae's gone with it."

"What?" She backed up hastily to let him pass, then hurried to catch up with him. "When?"

"Just a little while ago—I think I saw her leaving on horseback from the roof. I just want to make sure—"

They reached Danae's room and Ravagin pushed open the door . . . and she was indeed gone.

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